ELECTRICAL REVIEW

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THE TELEGRAPHIC JOURNAL AND
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VOL. XIX.—No. 473.

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ELECTRIC LIGHT *versus* PARAFFIN.

SOME of the most powerful arguments we have yet seen in favour of the adoption of safer portable lights than at present exist in our households are advanced in a pamphlet just issued, entitled, "The Moloch of Paraffin." In the 32 pages of this little work the writer, Mr. Charles Marvin, endeavours to direct public opinion to the position of the masses, who have been allowed for a whole generation to be sacrificed to the Moloch of Paraffin, without any serious effort to save them. The author very justly says:—"We insist upon safety lamps for the mines; let us do something to provide safety lamps for the masses." Mr. Marvin shows in the course of his remarks the construction of various oil lamps, and the dangers which accompany nearly all; he also explains the nature of paraffin, kerosene, and petroleum, and gives the opinion that the safest lamp in the market is that of Defries, a name not unknown in electric lighting circles. It is very dreadful to think that nearly every week at least one inquest is held in London alone from lamp accidents, and the thought suggests itself that a determined effort should be made by electricians to produce a cheap and constant portable electric light. The need of such a domestic convenience is daily making itself more and more apparent, but the demand has not yet been met in a manner which can be called satisfactory, except to a very slight degree. The attention of inventors should be turned to the battery which forms the source of electrical supply; glow lamps there are in profusion, and these can take care of themselves.

Of course to make such apparatus at all comparable with oil lamps, either in design or weight, is almost an impossibility. Perhaps the nearest approach to a solution of the problem, at least to our way of thinking, is the Schanschieff apparatus. We cannot rid ourselves, however, of the feeling that, except to the wealthy, this battery will not recommend itself, the cost of solution forming no inconsiderable outlay. We frequently hear of batteries which keep approximately constant for 10, 20, or even 70 hours, but generally when put to the test they are found wanting in lasting power, or are so large and heavy as to belie the claim of portability.

Up to the present we have not felt very sanguine that a discovery will ever be made which will bring about such a desideratum as a really portable and constant electric light, for the changes have long since been rung upon almost every possible combination of metals and liquids, and the majority of new batteries we hear of from time to time are merely revivals of old and half-forgotten ideas. Still we would not go so far as to say it is impossible, and so far as an incentive to further research is concerned, we would simply ask our readers who take an interest in this particular subject to peruse the pamphlet to which we have alluded. Assuredly those of the general public who peruse Mr. Marvin's forcible and terrifying remarks will feel a heavy sense of the insecurity attached to the employment of paraffin lamps, and the desire for something of a safer nature will soon make itself apparent.

PRACTICAL NOTES CONCERNING THE CONSTRUCTION, USE AND MANAGEMENT OF STORAGE BATTERIES.

By A. RECKENZAUN.

(*Continued from page* 513.)

IN secondary batteries the storage of energy is effected without transmutation, that is to say, the battery receives when being charged an electric current. and gives it out in the same form, the activity of the plates depending entirely upon the electrical energy which has first been expended upon them. In primary batteries, on the other hand, electrical energy is manifested or produced by chemical means; many run-down primary batteries may be re-excited by sending a reverse current through them, when they become secondaries, but then their action is exceedingly limited, because the spent or decomposd acid cannot, by means of this excitement, be changed into its original composition, the limited secondary capability created by such a process of charging being mainly due to the gases occluded in the plates. The true secondary battery is Grove's gas-battery or voltameter, where the evolved gases furnish an electric current direct; it consists of two similar platinum electrodes, one of which is coated or in contact with hydrogen and the other with oxygen. The amount of oxygen which platinum can store or hold in suspension is exceedingly small, the metal itself not being oxidisable, though it has a great affinity for hydrogen. The use and advantage of an oxidisable metal for the purposes of electric storage therefore becomes manifest, and it has been found by Planté that lead plates are easily oxidised, whilst they are capable of retaining their energy for a very long time.

Capacity of Storage Batteries.—It seems that the energy which can be stored in a secondary battery is really a measure of the amount of oxygen and hydrogen taken up by the plates within the liquid. The liquid in the case of lead accumulators is dilute sulphuric acid. If we place two clean pieces of sheet lead, separated from each other, in a vessel containing acid, and if we send a current through them of sufficient intensity to decompose the liquid into its constituent parts, we then observe that one of the plates will soon be covered with a brownish film. This film is peroxide of lead; the oxygen has combined with the plate which was joined to the positive pole of the charging apparatus, and this plate is commonly called the *positive.* We next disconnect the terminals of the lead plates from those of the generator, and join them to a conductor capable of absorbing the current, placing a galvanometer in the circuit at the same time, in order to measure the current given off; this first discharge will be very feeble and of an extremely short duration, though the charging may have been going on for a long time. The fact is that we have stored oxygen whilst the hydrogen escaped; the negative plate, being clean and smooth, could not retain this gas, the storage of which must be effected by occlusion. If we now reverse the poles of this Planté cell and recharge it, the clean plate will be oxidised, whilst the oxide on the other will be gradually reduced to metallic lead of a porous consistency; the surface is thus no longer smooth, therefore capable of occluding *some* of the hydrogen, and its *capacity* has increased slightly. By many reversals of this kind the lead plates are deeply acted upon, and at last a considerable storage capacity is obtained.

Throughout these notes we shall frequently use the term "active material" in lieu of peroxide, spongy lead, or oxide paste, meaning only those parts of plates which have the power of absorbing the gases given off during electrolysis.

"*Forming.*"—Planté called his method of preparing lead plates "forming." It was a tedious and expensive process. Faure introduced an important improvement by coating the plates at once, mechanically, with a porous material, a paste of red lead; he obtained thus quickly a considerable storage capacity by merely peroxidising the material on the positives, and at the same time reducing that on the negatives without any reversals. It really amounted to a thorough charging of the battery, although this first charge is also called "forming," because the oxide paste on the negative plates has to be reduced to metallic (spongy) lead before it can assume its full activity.

Originally, both the positive and the negative plates were pasted with red lead ($Pb_3 O_4$), but it has been found that in the process of "forming" the positive material was peroxidised long before the paste in the negatives could be reduced to spongy lead; hence litharge (Pb O) was substituted for minium in the negative plates, and this being a lower oxide, the requisite deoxidation could be effected with greater economy as regards energy and time. Further experience, however, showed that even with this distribution of different materials, the forming could not be completed at the same time in the negatives as in the positives, so that at last it became customary to form the negatives separately in special boxes containing "blind" positives; the energy expended in reducing litharge to spongy lead is at least twice that required for the peroxidation of red lead. The labour and care which such a double system of "forming" involves is not thrown away, indeed it is necessary for the preservation of the active material in the positive plates, which becomes extremely brittle if subjected to the same length of treatment as that of the negative plates.

Relation of storage capacity to quantity of active material.—One ampère of current in doing the work of decomposing acidulated water releases ·000158 of a grain of hydrogen, and its chemically equivalent proportion of oxygen per second. "In this action the energy connected to one equivalent H 1 grain, O 8 = water 9, is measurable as 6,840 foot pounds, and the electric conditions represent an E.M.F. of 1·5 volt." (Sprague, Electricity.) There being a definite relationship established between the current, time and volume of gas liberated, the capacity of an accumulator can best be measured electrically. In practice, for convenience, this capacity is expressed in ampère hours instead of ampère seconds, or coulombs; one ampère hour is equal to 3,600 coulombs. With regard to the amount of active material necessary for the absorption of given quantities of hydrogen and oxygen we find no reliable data suitable for immediate practical application. Chemical equivalents do not assist us, because in practice it is utterly impossible to distribute the materials in such a manner that every atom could do its duty. Gladstone and Tribe have made most elaborate experiments on the relative quantities of the two gases deliberated and fixed with a given current and in a given time, but in their publications we find no exact description as to the weight or volume of lead acted upon. Since a free access of the electrolyte must be advantageous it is perfectly natural to suppose that very thin plates, with a comparatively large surface, will give a greater storage capacity for a given volume of active material than thick plates where diffusion is more difficult. We are, for mechanical reasons, forced to employ plates of a reasonable thickness, and with the aid of examples taken from well-known forms we may arrive at practical conclusions pointing to a maximum useful effect. The following figures bearing upon this question may be useful; the author has deduced these from exhaustive experiments made by him with accumulators of different types supplied by the Electrical Power Storage Company. Weights and dimensions refer to the active material (paste) only, and no account is taken of metallic supports.

(*a*.) *Cell used for locomotive purposes.*

Capacity 150 ampère hours.

Weight of peroxide in positive plates ...	6·07	lbs.
" " spongy lead in negative plates	5·43	"
Total weight of active material ...	11·50	"

The capacity per pound of active material is therefore 13 ampère hours.

There are 23 plates in this cell, 11 positives and 12 negatives; the object of the odd number of plates is to have for all the positive plates in a cell two opposing negative surfaces. In each plate the active material consists of 560 small square slabs (square holes filled with paste); the free surface exposed to the electrolyte by these 560 tiny slabs, when counting both sides is 53·7 square inches. The thickness of the positive plates is one-eighth of an inch, and of the negatives three-thirty seconds; the volume of peroxide in the positive plates is thus 36·9 cubic inches, whilst the spongy lead in the negatives occupies 30·23 cubic inches.

(*To be continued.*)

RECENT ADVANCES AND IMPROVEMENTS IN THE APPLICATION OF ELECTRICITY TO RAILWAY WORKING.

ELECTRICAL GAS VALVE FOR CONTROLLING THE SUPPLY OF GAS IN RAILWAY TRAINS, &c.

THE lighting of railway carriages is a question which has for many years occupied the attention of railway companies. That which at one time was felt to be such a comfort—the old oil lamp—is now, by a general concensus of opinion, denounced as out of date, behind the times, an intolerable nuisance, &c. It is questionable if the oil lamp with which the majority of our railway carriages are still lighted, was ever provided for the purpose of reading. Be that as it may, there can be no question of the demand which now exists for such. That such a requirement exists is acknowledged by the companies themselves in the efforts which are, from time to time, made by one or the other towards the production of some improvement. Thus we find at the present moment no less than four forms of lighting in use, viz., the oil lamp, gas, petroleum, and the electric light.

Of these the petroleum lamp is the most novel, and although we can have in these columns little to do with it, it may be worth mentioning that it is quite possible it will some day compete closely with gas and electricity as an illuminant for railway carriages. It is cheaper than the vegetable oil used for the ordinary lamp; it is cheaper than gas, and it promises to become a very convenient form of light for the purpose referred to.

On the Metropolitan trains gas has been employed for some time, but it is only recently that it has been brought into use for long journey trains—trains travelling in the broad daylight. The London and South Western and the Midland, together with some of the other leading companies have now, we believe, several such trains in daily use.

Where trains are, practically, always in the dark subway, there is no need of so regulating the supply of the gas that it shall be at its maximum when the carriage is in the dark, and turned down to a reasonable minimum when travelling in the open daylight. But where trains travel long distances without stoppage, and where such distances include several tunnels, such a regulation of the light, or of the supply of gas, is desirable as tending towards economy and adding to the comfort of the passenger.

Such a system of control is probably only practicable by the aid of electricity, and recognising its advantages, the Midland Railway has fitted the whole of its Scottish through trains, together with some of its Metropolitan stock with a system by which the supply of the gas is controlled from the guard's vans in any part of the train. Thus, prior to the departure of the train, the gas is lighted and turned down to its required minimum. Just previous to its entry of a tunnel the guard turns it up, and again on the train emerging from the tunnel he turns it down. Taking it that, when at its minimum, the light is consuming one-half that which it burns when at its full height, the saving on a long journey—say from London to Carlisle—is very considerable, being little more than half that which would otherwise be consumed. The invention is that of Mr. W. Langdon, the company's electrician.

Fig. 1 is an elevation representation of the valve; fig. 2 being a vertical cross section of the same. A is a small box, preferably formed of brass or other non-magnetisable metal. A′ is its lid, packed around its edges by India-rubber. C, C are electro-magnets having their pole-pieces carried through, in fact screwed into the side wall of the metal box. D is the armature of the electro-magnet pivotted at *d*, and carrying upon its opposite end the valve pad, E. The movement of the armature is controlled by a helical spring, F, the tendency of which is to draw it away from the cores, *c*, *c*, until it rests upon the stop pin, G, which is, when adjusted, rigid and permanently fixed within the box, A. Its opposite movement, that is the movement towards the cores, *c*, *c*, is controlled by an adjustable screw, H, passing through the wall of the box, A, and which is provided with a conical point so arranged that its point shall engage with the end of the armature, and thus enable the operator by screwing it in or out, to regulate the space between D and the poles, *c*, *c*.

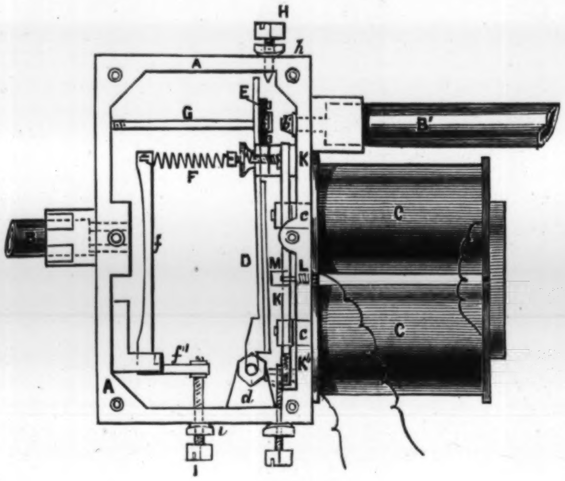


FIG. 1.

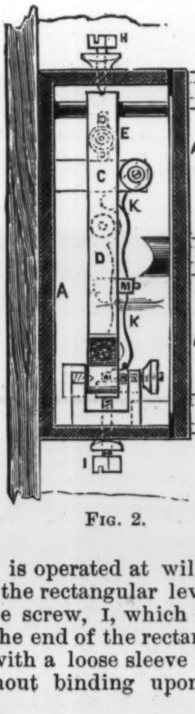


FIG. 2.

The spring, F, is operated at will as regards its tension upon D, by the rectangular lever, *f*, *f*′, the end, *f*′, moving with the screw, I, which is provided with a check nut, *i*. The end of the rectangular lever marked, *f*′, is provided with a loose sleeve so that it may work loosely or without binding upon the screw, I. On screwing I further within the box, A, the tension of the spring, F, is increased, and *vice versâ*.

K, more clearly shown in fig. 2, is a locking bar, the object of which is to prevent any erratic movement of the armature, such as would tend to suppress the supply of the gas to the orifice of the tube, B′. It is pivotted at K′, and controlled in its backward movement by the pin, L, against which it is normally held by the helical spring, K″. To K is fixed a bar, M, so arranged and so shaped that it shall, when the locking bar, K, is in its normal state, uninfluenced by any magnetic attraction from *c*, *c*′, pass under the armature, D, and so prevent any motion on its part. On a current being passed through the coils, K becomes attracted towards *c*, *c*, when the projection at the end of L passes away from D, leaving the armature free to act and so close, or nearly close, the orifice *b*, by the pad fixed to the end of the armature.

The inlet pipe by which the gas enters the valve box is shown at B; the outlet, that which feeds the lamps, is shown at B′. The pipe, B, is connected to the gas reservoir fixed beneath the bed of the vehicle. The pipe, B′, communicates with the several burners provided for the several lamps employed in the vehicle.

The box, A, is placed within another box or case, not shown in the drawings, within which are arranged terminals to which the coil wires and line wires are attached. One of these boxes is fixed to each vehicle, the gas of which it is desired to control. Two wires are usually employed, one for the line, one for the return wire; but if the rails are employed for the latter, then only one wire is needed.

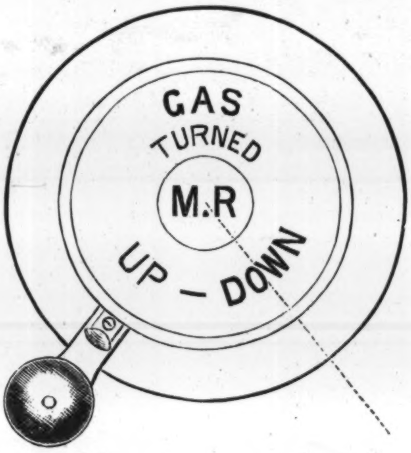


FIG. 3.

In the guard's van is arranged a battery and a switch. The latter we illustrate in fig. 3. Its electrical arrangement will be readily understood when we say that it merely consists of a make-and-break arrangement. If it is desired to turn the gas up the guard passes the lever over to the up side, and if it is desired to turn it down he passes it to the opposite side. In either position it is retained by a small catch-piece.

The vehicles throughout the train are coupled up electrically; the coupling employed being one of a novel and special character, so arranged that the individuality of the wires may be preserved. Of its construction, however, we speak more fully further on.

Let us now assume that it is required to turn the lights of a train down to that degree which has, by the adjustment of the several parts, been fixed as the minimum. The commutator or switch in the guard's van is thereon turned to "off." The battery current now flows throughout the circuit. In passing through the coils, *c*, of each valve fixed upon the several vehicles, it actuates, first, the locking bar, K, and then the armature, D, attracting it to the cores, *c*, *c*, bringing the pad, E, at the extreme end of the armature into such a position as will partially close the orifice of the feed-pipe, B′. The supply of gas is thus reduced, and the lights are accordingly turned down. On the switch being turned to "on," the current is cut off, and under the influence of the springs, F and K″, the armature and the locking bar resume their normal position, and the flow of the gas goes on uninterrupted.

This system of controlling the gas in railway trains is covered by two patents; one, that which has been already described, the other effecting the desired object by a pad arranged upon a permanent magnet, which is so placed that it shall play between the poles of an electro-magnet having steel cores. This valve will be found illustrated in fig. 4. A is the gas supply or inlet tube, B that leading to the burners of the several lamps, C is the box containing the valve, D the electro-magnet, E the permanent magnet, pivotted at *e*, carrying the pad or stop valve, *f*; H, H′, are stops for limiting the movement of E; *d*, *d′*, the cores of the electro-magnet; G, the locking bar, pivotted at *g*, *g*. The action of this instrument is precisely the same as that more fully described, except that it is operated by momentary currents of a positive or negative character, as may be required. The switch or commutator employed in the guard's van is necessarily on the reversing key principle, with a mid-way position. This form of instrument is available, and is being used for the regulation of gas at large stations. A valve is inserted at the point of supply for each platform or section of platform, where the platforms are arranged to receive two or more trains; and a switchboard is provided at a convenient point, from which the gas is manipulated as required to meet the work of the station.

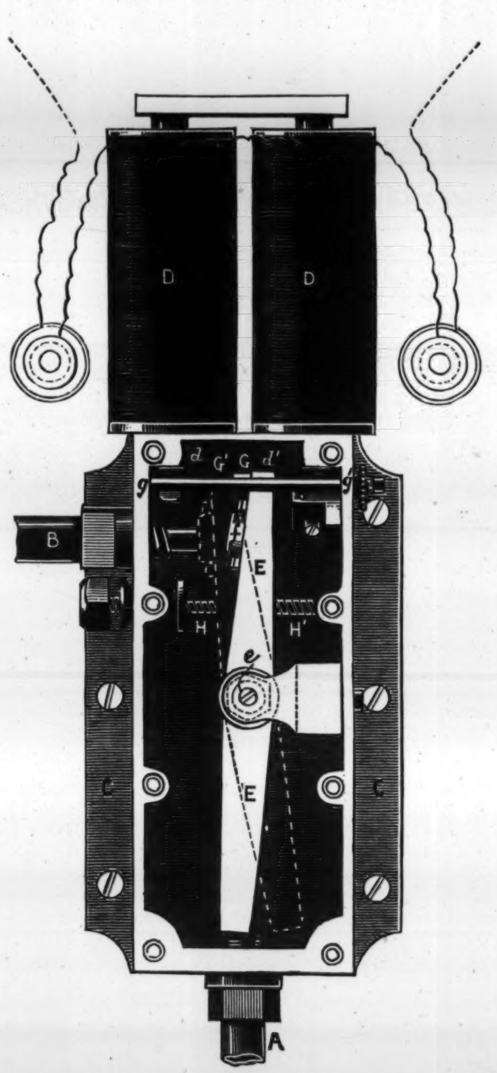


FIG. 4.

ELECTRICAL COUPLING FOR RAILWAY TRAINS.

In dealing with the application of electricity for controlling the supply of gas employed for the illumination of railway trains, we referred to a special form of electrical coupling made use of in connection therewith. It will, however, be understood that the coupling is designed for use in connection with any form of electrical communication required for railway trains.

Where the communication is composed of one wire only, the rails being employed for the return wire, any simple form of coupling may be devised; but experience has shown that the employment of the rails is unsatisfactory, especially when equability of resistance is desirable.

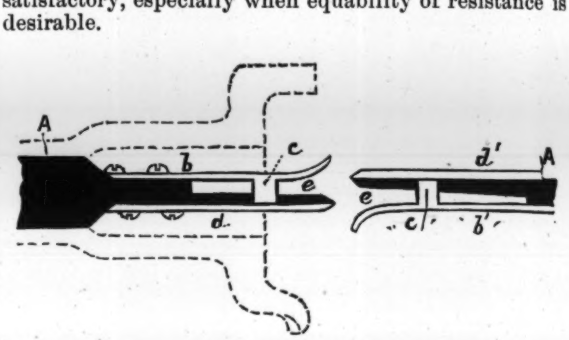


FIG. 1.

Where two wires are employed, it becomes necessary in designing the coupling that provision should be made for insuring connection between the proper wires. Thus, so that wire A of one carriage may not be joined through to wire B of the other carriage. Further, that the coupling may be readily joined up and as readily disconnected; and, under certain circumstances, that the two wires shall, immediately on the severance of the coupling, become connected together. For electric lighting with the lamps in parallel, of course such an arrangement would not be required. In that case the necessity for connecting the proper line wires would remain, but the arrangement of the parts would be such that the connecting portions of each coupling would remain asunder during the time the coupling was severed.

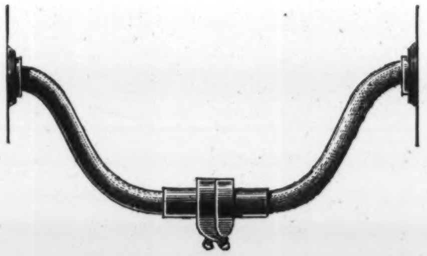


FIG. 2.

To insure the connection of the proper wires it is necessary the coupling should be joined up aright. This is accomplished by arranging the electrical coupling within a small mechanical coupling designed in imitation of the automatic brake coupling, which is set together in the same manner; the automatic brake form of coupling being adopted for the reason that its mode of coupling up is so well understood by those who have to make up the trains.

In the illustration the electrical connection is shown in full line, one half of the mechanical coupling being dotted in. A is a block of ebonite to which is fixed a spring, *b*, provided on either side with a small ear or contact piece, *c*. *d* is a rigid bar of brass, arranged upon the block, A, diametrically opposite to *b*, and having its inner face, *e*, insulated except at the point where the ear-pieces, *c*, rest upon it. The line wires from either side are attached to the springs, *b*, *d*, respectively. On the coupling being joined up, the rigid bar, *d'*, presses upon the spring, *b*, which it carries away from its contact with *d*, whilst *d* in like manner pressing upon *b'*, operates it in a similar way. The wire attached to *d'* is now in connection with that attached to *b*, and that of *b'* with that of *d*, the communication being complete. The block, A, is firmly fixed within the mechanical coupling, and the wires are carried within a piece of flexible tubing to the centre of each carriage, at a point clear of the ordinary carriage couplings, but still well within the reach of the man coupling up. Fig. 2 shows the coupling joined up.

THE NEW FIELD SEXTUPLEX TELEGRAPH.

THE multiplexing of telegraph lines has been effected in several ways, says the *Electrical World*, among them being the methods of compensation and neutralisation, as in the duplex and quadruplex ; the method of synchronism, as in the Delany and Callahan system ; and also the method of harmonic telegraphy, such as that devised by Gray. We might also mention the increase of the capacity in lines effected by the methods of simultaneous telegraphy and telephony over the same wire.

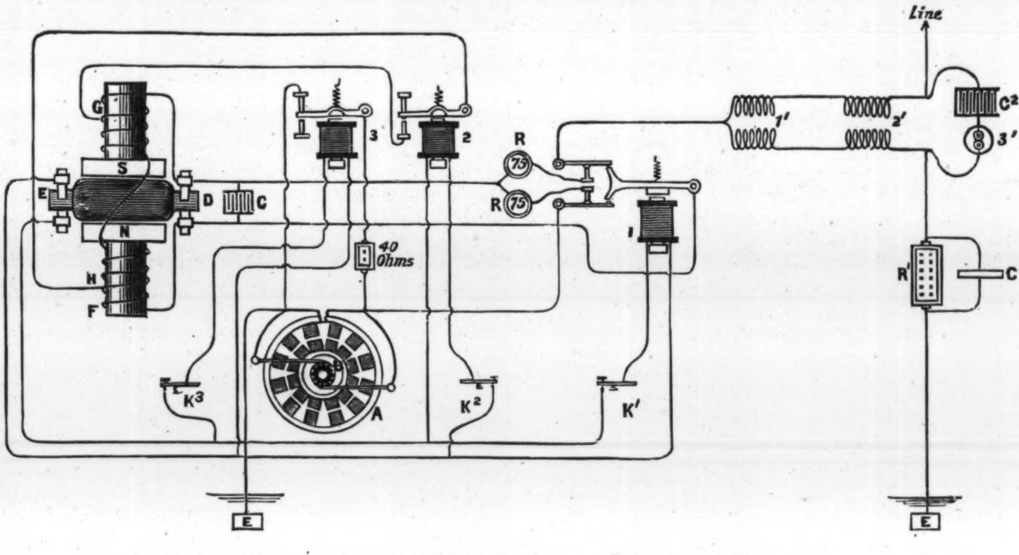


FIG. 1.—THE NEW FIELD SEXTUPLEX—DIAGRAM OF CIRCUITS.

In the new sextuplex telegraph system of Mr. Stephen D. Field, while some methods are employed analagous in some cases to those used in the systems above mentioned, the system as a whole is decidedly novel and interesting, and, judged from the results of its practical operation which we recently had occasion to witness, is destined to an early application.

Mr. Field has started out with the well-known fact that currents of different "quality," if the expression may be allowed, if sent simultaneously over the same wire, do not interfere with each other, and can be caused to operate corresponding receiving instruments at the other end of the line. Thus in the new system three different qualities of current are employed, viz., a direct current of increasing and decreasing strength, operating a neutral relay ; a reverse current, operating a polarised relay ; and a rapid vibratory current, which sets a telephonic diaphragm in rapid vibration. These three currents acting upon corresponding receiving instruments, do not interfere with each other, as will be shown below ; and as each one type of working is duplexed by the well-known compensating method, the line is evidently capable of transmitting three messages in either direction, or six simultaneously.

The arrangement of circuits and apparatus by which these results are effected is shown in the accompanying diagram, fig. 1. We may remark at the outset that not a single cell of battery is employed for any purpose, both the main line and locals deriving current from a dynamo. The latter is shown at F, and the armature, as will be seen, is provided with two independent sets of windings, which deliver current respectively to the commutators, E and D. The local currents are taken off the commutator, E, the circuit connecting with the three local transmitters, 1, 2 and 3, which are manipulated in the ordinary way by the keys, K^1, K^2, K^3. The main current is taken from the armature from the commutator, D, this current serving to actuate the neutral and polarised relays which are shown diagrammatically at 2' and 1' respectively. It will be noticed that the dynamo, F, is shunt wound. Its armature is of 150 ohms resistance, and it has an E.M.F. of 300 volts at 500 revolutions. The shunt coil is divided so as to give a long and a short shunt at the points, G, H, depending upon whether the transmitter, 2, be closed or open. The resistance of the short shunt is 540 ohms, and that of the long shunt is 6,000 ohms. Hence it follows that by pressing K^2 the armature of transmitter 2 is attracted to the front stop and short circuits the long shunt of the dynamo. This, of course, causes an increase of current in the short shunt, the strength of the field magnets remaining constant ; and hence there ensues a decreased effect in the line current, and it is upon this increase and decrease of the direct current that the neutral relay, 2', operates. We will not for the present enter into a description of this relay.

Transmitter 1 operates a pole changer by which reverse or alternate currents are sent over the line which actuate the polarised relay shown diagrammatically at 1'. The pole changer is so adjusted as to be continuity-preserving as regards the line, but with a very slight break towards the dynamo.

It is evident that the continuous current designed to operate the neutral relay has no effect upon the polarised relay ; but the reverse currents designed for the latter would affect the neutral relay if some provision were not made to prevent this disturbance. This has been recognised by Mr. Field, and he overcomes the difficulty in a very simple manner.

The neutral relay, 2, is shown in part perspective in Fig. 2. To understand its operation, we will premise that when ordinary reverse currents are sent through a neutral relay the armature is kept in a state of vibration, breaking contact momentarily at each reversal, but being immediately re-attracted. With the arrangement of the neutral relay, shown in fig. 2, the reverse current has no effect on the armature. This result is obtained by taking advantage of the induced currents generated by the reversals. As will be seen, the core of the relay is lengthened, and has a bobbin, B, surrounding it. The latter is connected to another small bobbin, C, surrounding a core, H, which is placed opposite a small cylinder of iron, K, acting as an armature and attached to the lever of the relay. The reversal of current in the relay bobbin causes a change of polarity in the core, and the tendency is to momentarily throw off the armature; but at the same instant of the reversal of polarity an induced current is set up in the bobbin, B, which is in opposite direction to the primary, and which, in circulating through C, tends always to magnetise the core, H, oppositely to that of the main core, and hence, with a corresponding influence upon the small armature, K. The result of this is evidently that with two opposite influences acting upon the lever, it will remain stationary and insensible to the effects of the reverse currents.

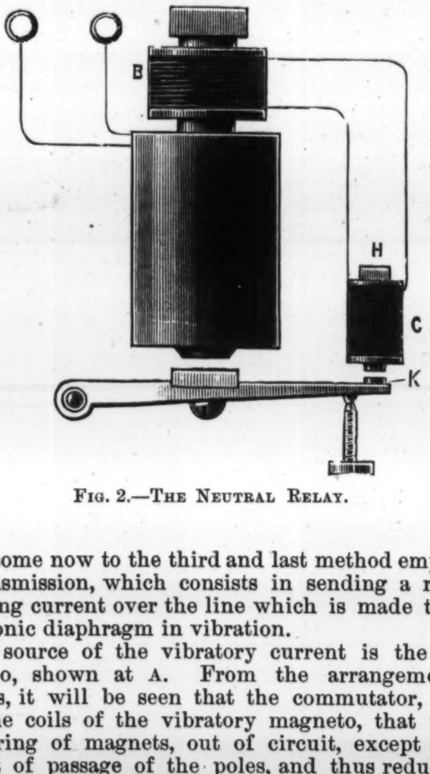


FIG. 2.—THE NEUTRAL RELAY.

We come now to the third and last method employed in transmission, which consists in sending a rapidly vibrating current over the line which is made to set a telephonic diaphragm in vibration.

The source of the vibratory current is the small dynamo, shown at A. From the arrangement of circuits, it will be seen that the commutator, B, cuts the line coils of the vibratory magneto, that is, the outer ring of magnets, out of circuit, except at the instant of passage of the poles, and thus reduces the resistance of the circuit from 160 to 5 ohms, which changes evidently occur in continuous rapid succession, sending a vibratory current over the line. These currents charge the condenser, C^2, at the distant station, which tends to increase their abruptness, and thence pass into the vibratory receiver or relay, 3′. The latter is shown in detail in fig. 3. It consists of a horseshoe magnet, M, upon which are mounted the coils, F, through which the vibratory current from the line are made to pass. Opposite the poles of the magnet is placed the diaphragm, D, which has a platinum pin, C, mounted on its centre. Resting upon this pin is another, B, which is attached to the end of a lever which, together with the diaphragm, D, is in circuit with a sounder, S. A local battery is here shown in circuit merely for the sake of clearness, the current being in reality taken from the local leads of the dynamo.

Now, when the key, K^3, is open, the armature of the transmitter, 3, is on its back stop, and closes a circuit including a 40 ohms resistance, so that the current from the vibratory generator is short circuited and does not go out over the line. When the key, K^3, is depressed, however, the armature of 3 is attracted, breaks the short circuit, and the vibratory currents then pass out to the line. Arriving at the receiver, shown in fig. 3, they set the diaphragm, D, in rapid vibration so that the pins, B and C, are given a rapid make and break motion; in fact, so rapid is the motion and so short a time are the pins in contact, that the local circuit is practically open and the sounder has not time to act, being purposely made sluggish in its movements; the local circuit remains open, then as long as the key, K^3, is depressed. The dots and dashes of the key are therefore received on the vibratory receiver as a series of "buzzes," which are transformed in the manner described into dots and dashes on the local sounder, S.

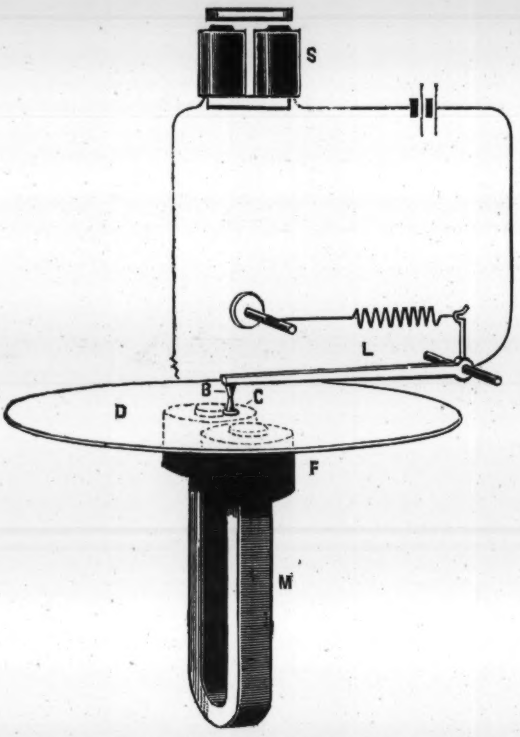
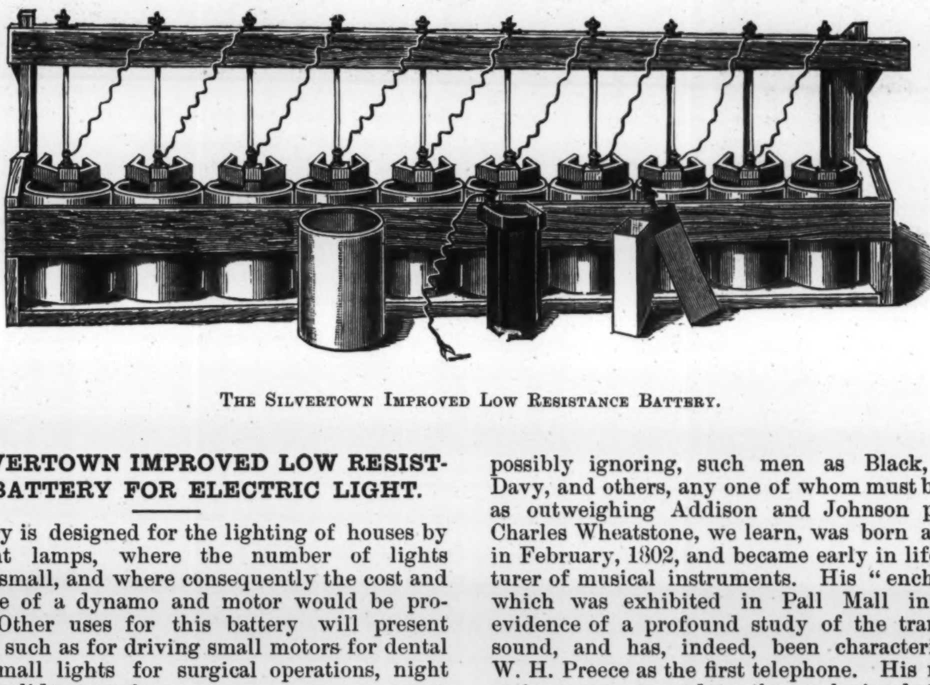


FIG. 3.—THE VIBRATORY RECEIVER.

Both the relays as well as the vibratory receiver are wound differentially, as in the ordinary duplex service. The action is very smooth, and ordinary changes of condition on the line do not affect the working. The static capacity of the line at the time of our examination of the apparatus, when increased from that of a few miles to that of a line over 400 miles in length, required only a slight readjustment of the vibratory receiver.

COMPRESSED AIR AND ELECTRIC LIGHTING.

ONE of the arguments put forward in support of the Birmingham compressed air power scheme is that it will greatly cheapen and facilitate the adoption of the electric light. In his evidence before the Select Committee on the Electric Lighting Bills last Session, Major Armstrong stated that in an electric lighting installation more than half the total cost goes in wages as a rule. Upon this it is urged in favour of this scheme that practically no wages will be required, because the compressed-air high speed motor driving the dynamo direct needs virtually no attendance, and can be stopped or started by simply pressing an electric button. That being so, the cost of producing the electric light may be reduced by one half. It is further pointed out that the progress of the electric light has been seriously retarded by the difficulty and expense of driving the dynamos by steam or gas engines; but when they can be driven by compressed air, delivered at 5d. per 1,000 cubic feet, and the cost of installations considerably reduced, electric lighting is sure to spread extensively. And one of the things promised is that this service will be available at all times, night and day, for electric lighting, tramway cars, lifts and other purposes; and it is claimed for this new motive power that users may apply it to their existing engines; that they will be able to economise the space formerly taken up by boilers, coal stores and ash pits; that instead of being restricted by the capacity of their boilers they will be able to draw to a practically unlimited extent upon the reserves maintained in the air mains; that in large mills they will be saved the cost of extensive shafting and of heavy foundations for large engines; that smoke nuisance, the risks of boiler explosions, and the cost of water carriage and much labour will be obviated; that the exhaust air from the engines will supply a pure atmosphere to the workshops, and that there will be a saving of 20 per cent. as against the cost of steam power. Many other advantages are predicted, and a profit of 16 per cent. upon the outlay for 6,000 H.P. is estimated.



THE SILVERTOWN IMPROVED LOW RESISTANCE BATTERY.

THE SILVERTOWN IMPROVED LOW RESISTANCE BATTERY FOR ELECTRIC LIGHT.

THIS battery is designed for the lighting of houses by incandescent lamps, where the number of lights required is small, and where consequently the cost and maintenance of a dynamo and motor would be prohibitory. Other uses for this battery will present themselves, such as for driving small motors for dental purposes, small lights for surgical operations, night lights in invalid rooms, &c.

The battery is now made in two sizes, and consists of a round stone glazed outer cell of about three pints capacity for the smaller size, and 10 pints for the large size and contains a suitable porous cell; the zinc and carbon electrodes are of ample capacity and size for the work done. The solutions used are cheap and almost non-fuming.

The whole battery of the desired number of cells is set up in a skeleton frame, and fitted with rectangular lifting bars and rests to allow of the zincs being withdrawn from the solution when the battery is not in action; this is desirable, as otherwise there would be a loss should the zincs be left immersed, even when no work was being done.

By this arrangement the prime cost is low, and the cost of the solution very moderate, so that for cost and maintenance the battery compares very favourably with any other type, and possesses the advantages of being self-contained and easily examined, while at the same time the solutions are as above stated almost non-fuming.

For a battery, say of 10 cells of the smaller size, the space occupied would be 56 inches by 7 inches, and for six cells of the large size, 48 inches by $9\frac{1}{2}$ inches, E.M.F. in open circuit = 2·08 volts per cell. Working current for large cell, 5 ampères, 20 hours, and for small cell, $1\frac{1}{2}$ ampères, 20 hours.

REVIEWS.

Lives of the Electricians: Professors Tyndall, Wheatstone, and Morse. First Series. By W. T. JEANS. London: Whittaker & Co., and G. Bell & Sons.

(SECOND NOTICE.)

Profs. Wheatstone and Morse, though not what the Americans profanely call "one-horse men," were both much more typically and exclusively electricians than Prof. Tyndall.

Mr. Jeans sets out from the earliest dawn of the electric telegraph, as we may trace it in the writings of Strada, Sir Thomas Browne, and Schwenter, and informs us that it was sneered at by Addison and Dr. Johnson, whom he ventures to call "the two greatest intellects in England in the eighteenth century," overlooking, or possibly ignoring, such men as Black, Cavendish, Davy, and others, any one of whom must be considered as outweighing Addison and Johnson put together. Charles Wheatstone, we learn, was born at Gloucester in February, 1802, and became early in life a manufacturer of musical instruments. His "enchanted lyre," which was exhibited in Pall Mall in 1821, gave evidence of a profound study of the transmission of sound, and has, indeed, been characterised by Mr. W. H. Preece as the first telephone. His next investigations were turned to the analogies between sound and light, and his succeeding inventions were the kaleidophone and the terpsiphone. In 1833 he contributed to the Royal Society an important paper on Chladnis's sound-figures. He was also an active member of the London Phrenological Society, and in 1832 he read a paper on dreams and somnambulism. Next we find him engaged with the construction of speaking machines, which in these days of stump-oratory would be extremely superfluous. In a paper communicated in 1831 to the Journal of the Royal Institution, he laid down principles which have since found their full application in the telephone and microphone. In 1834 he devised the method for measuring the velocity of electricity in transit by means of a revolving mirror. This discovery at once spread his fame throughout the world of science, and the principle has since been applied by Fizeau and Foucault to the measurement of the speed of light. It is here stated that his paper on "The Prismatic Analysis of Electric Light," read before the British Association at their Dublin meeting in 1835, led the way to spectrum analysis. This is not absolutely certain. The observations of Wollaston in 1802 and of Fraunhofer must not be overlooked. In 1822, Sir J. Herschel remarked that by volatilising substances in a flame a very delicate means is afforded of detecting certain ingredients by the colours they impart to certain of the dark lines of the spectrum. In 1834, Fox Talbot suggested optical analysis as the most delicate means of detecting minute portions of a substance.

In 1837 we find Wheatstone calling attention to the capabilities of the thermo-electric pile; whilst a little earlier he was engaged, in concert with Faraday, in devising lightning conductors for the Navy.

In 1837 he comes before us as the discoverer, or, to say the least, an independent discoverer, of the electric telegraph. The idea had been for some time "in the air," but according to the evidence here adduced, Wheatstone was the first who actually constructed a practical telegraph and brought it into successful operation. Concerning this invention no little controversy has arisen. Even Mr. Latimer Clark, an unfriendly witness, admits that Cooke's proposed telegraph "is disappointing," and that the first instrument used between Camden Town and Euston was Wheatstone's.

In 1840 Wheatstone produced three inventions, his dial telegraph, his printing telegraph, and his electric clock. In 1843 he stated that he had for some years employed the "bridge," now known by his name for measuring electric currents. Passing over various inventions bearing on the improvement of the telegraph, we come to Wheatstone's dynamo, described in a paper read before the Royal Society on February 4th, 1867, on the same day as one on the same subject by Sir William Siemens. The question of priority is very fully discussed.

His next great invention is the stereoscope, which was lauded and admitted by Sir D. Brewster, who afterwards turned round and endeavoured to rob Wheatstone in connection with the invention! For all these particulars we must refer our readers to the book itself, space allowing us to do no more than refer to his death, which took place at Paris, October 19th, 1875. An eloquent éloge of the deceased was delivered by M. Dumas, on behalf of the French Academy of Sciences. If Wheatstone passed from the service of music to electricity, his great compeer Morse devoted himself first to the sister arts of painting and sculpture. His telegraph, on the printing system, seems to have been conceived, perhaps, earlier than those of Wheatstone and Steinheil; but it was not publicly demonstrated until September, 1837. The difficulties which Morse had to encounter were all but overwhelming. His means were slender, since his devotion to the telegraph had caused him to neglect art, from which he had already drawn not merely fame but emolument. The appliances which he required for his experiments were then scarcely to be procured in America. A rival claimant for the honour of the invention appeared in the person of a Dr. Jackson, who had been Morse's fellow passenger on a return voyage from Europe, and to whom the latter had been, perhaps, imprudently communicative. Fortunately sufficient evidence was forthcoming to refute the pretensions of Jackson. Morse obtained his American patent in 1840. His application for an English patent, made July 12th, 1838, of course under the "old law," was necessarily refused, on account of a prior publication made in the *Mechanics' Magazine*. In France, where the law is different, he "got a patent without any difficulty," but could not uphold it, as it was impossible to work the process within the term of two years. In Paris he met with Daguerre and Niepce, and his attention was for a time turned to photography, in which, in concert with Dr. G. W. Draper, he effected some well-marked improvements.

In 1843 it was proposed in Congress to appropriate 30,000 dollars to be expended in experiments to test the merits of Morse's telegraph. An attempt was made to crush the measure with ridicule. One Cave Johnson, who on this occasion acted as the buffoon of the House, "proposed that one half the appropriation should be given to a Mr. Pisk to enable him to carry on experiments in mesmerism!" Another luminary named Houston moved that "Millerism," whatever that may mean, should be included in the benefits of the appropriation. The Chairman, though formally called, declined to rule this transparently "bogus" amendment out of order, and ultimately in a House of 172 members the Bill was carried by the narrow majority of six.

Even then, however, the inventor's trials were not ended. When he applied for permission to lay his telegraphic line along the Baltimore and Washington railway, one of the older directors said that "this idea of Mr. Morse, though it appeared plausible to theorists, dreamers, and men of science, was regarded by all practical people as destined to certain failure . . . . He felt conscientious scruples in giving a vote which would tempt a visionary enthusiast to ruin himself." However, in spite of the kindness and the conscience of this obstructionist the resolution was adopted.

Morse, as it is here mentioned, always asserted that he was the inventor of the first telegraph, and contended that the invention of Wheatstone and Cooke was a semaphore. This contention must be regarded as a verbal quibble, more worthy of a politician than a man of science.

One of the most brilliant passages in the life of Morse was the part he played in establishing telegraphic communication between Britain and America. He entertained the hope that the telegraph might become a means of promoting peace and good-will among the nations. Alas, it has been already pressed into the service of war. His suggestion that under sea telegraph lines should be held sacred in time of war will, we fear, never be accepted in practice, at least by one of the great powers.

We are surprised to find the author quoting in a passage from J. L. Ricardo, evidently directed against the patent laws, the assertion that glass was invented in 1310! Surely he must know that glass was well known in ancient Egypt.

We regret to notice in this work at least one instance of that modern ungrammatical vulgarism which appears in such common expressions as "he was awarded a medal," or the like, instead of "a medal was awarded to him." This is the more to be regretted, since the author, if a man of science, appears to be decidedly a man of letters, and since his work is not merely "readable," but fascinating, and will, we foresee, be devoured both by young and old.

We may call attention to two typographical errors: the name of the Danish savant Oersted is in one passage written "Oerstead," and the Danish order of knighthood "Dannebrog" has been converted into "Danneborg."

FIRE AND LIFE RISKS IN ELECTRIC LIGHTING.

DR. GEORGE H. BENJAMIN read a paper on this subject before the Electric Club at the Hotel Dam, New York, on November 4th, but his views were not accepted with that amount of favourable acclamation which the author probably desired. The discussion on the paper, we are told, was bitter and personal in the extreme. Dr. Benjamin bases his opinion that much more rigid restrictions than at present obtained should be enforced upon the number of disastrous fires and terrible accidents which have lately been recorded. The possibility of such slaughter as has taken place, he says, should be guarded against by absolute prohibition and, if necessary, by statutory enactment making it a penal offence to direct or employ men, however experienced, in that class of electrical work where the slightest oversight or unavoidable slip means sure and instant death.

He contends that the subject should be looked at in a broad light and apart from the narrow prejudice of business. To make an electric plant perfectly safe may necessitate slightly increased cost of construction, although personally he is inclined to doubt the fact. But even admitting such to be the case, the perfect immunity from danger, the decreased cost of insurance, and the general confidence engendered in the public mind will be a good interest upon such additional outlay. After a careful examination of the rules of fire boards and underwriter's associations all over the world, Dr. Benjamin has compiled the following, which he has endeavoured to make as concise and clear as possible, and with as few onerous conditions as are compatible with absolute safety to life and property :—

I. RULES TO BE OBSERVED IN CONVEYING CURRENTS OF CONSIDERABLE QUANTITY OR ELECTROMOTIVE FORCE IN AND THROUGH BUILDINGS.

Rule 1.—The degrees of E.M.F. that may be employed in an electric circuit within any building should not exceed 100 volts for alternating currents or 200 volts for continuous currents. No departure will be allowed from this rule except by special permit, and then only for arc installations in large buildings where the whole plant is absolutely removed from public interference.

Rule 2.—The conductivity of all wires should be such that 100 per cent. more current can be transmitted through them than that estimated as their proper carrying capacity without increasing their temperature above 150° F.

Rule 3.—No naked conductors allowed in buildings.

Rule 4.—All light and power circuits must be entirely metallic, and of properly insulated wire. The employment of gas, water, or steam pipes, or the earth as a part of circuit is positively prohibited.

Rule 5.—All conductors should be thoroughly well insulated with a material or materials as non-inflammable as possible, and which will not fray or become loose, melt at a low temperature—below 150° F.—or absorb moisture.

Rule 6.—All conductors that are exposed to moisture must be provided with a waterproof insulating cover.

Rule 7.—Where practicable, all conductors in factories, or similar buildings, shall be so placed as to be readily inspected and tested.

Rule 8.—No conductor, whether bare or insulated, shall be laid in wet cement, plaster, mortar, or other similar material.

Rule 9.—All conductors carried through or within walls, floors, or partitions must be enclosed in separate metal, earthenware, terra-cotta, or asbestos board tubes or their equivalent, and which should be slightly larger in their inside diameter than the conductors they are designed to carry. Conductors should not be placed above each other in such a manner that water could make a cross connection. Especial care should be taken to protect all concealed wires from mechanical injury.

Rule 10.—Conductors conveying currents of considerable E.M.F. or quantity, as for arc lights, power, charging of storage batteries, and the like, excluding secondary distribution, should be placed at least 6 inches apart, the same distance from conducting bodies, and at least 2 feet from other wires of smaller diameter placed parallel therewith.

Rule 11.—Conductors conveying alternating primary currents of high E.M.F. must be kept a minimum distance of 12 inches from each other, and enclosed in separate highly insulating fireproof casings.

Rule 12.—Conductors conveying currents for incandescent lighting, and having a less E.M.F. than 200 volts, and run along walls or other exposed supports, should be placed at least 2½ inches apart, and a similar distance from all other wire or metallic bodies, except as provided in Rule 9.

Rule 13.—Conductors for arc or incandescent lighting currents should be placed in grooves, mouldings, or casings of wood or dry plaster or like material, preferably arranged along the cornice line; and in such cases there should be a septum of the wood or material, having a thickness of 3 inches for arc currents and ½ inch for incandescent currents between the wires; wooden mouldings may be rendered fireproof by painting them with a of tungstate of sodium in water.

Rule 14.—Single or twin-wire insulated conductors may be carried through electroliers or gas fixtures, but especial care must be taken to insulate such conductors from the metal parts of the fixtures.

Rule 15.—The location of all concealed conductors should be plainly designated by an appropriate mark.

Rule 16.—No metallic staples, nails, hooks, or devices for attaching and supporting electrical conductors should be employed in buildings. Wooden cleats or porcelain saddles must be provided. Two conductors conveying high potential currents should never be included in the same saddle or cleat.

Rule 17.—Twin-insulated wire may be employed in branches feeding single incandescent lamps in parallel of the main circuit.

Rule 18.—All joints should be mechanically and electrically perfect, the ends cleaned, united by solder (acid flux employed), and wrapped with insulating tape.

Rule 19.—Safety fuses should be provided at both points of junction of a branch circuit with a main circuit, and the conductivity of such fuses should in no instance exceed 50 per cent. of the current designed to operate the devices in circuit.

Rule 20.—Where practicable, all safety fuses for each room should be placed in a conveniently located fireproof box, so that they can be inspected or renewed without inconvenience or injury to the premises.

Rule 21.—A cut-out switch which can be operated by the firemen or police must be placed in the circuit in a well-protected and accessible place.

Rule 22.—Magnetic cut-outs or circuit breakers should be used in preference to fusible strips on arc or power circuits, and should be adapted to be thrown into action by any increase of current amounting to 50 per cent. or less as specially required.

Rule 23.—Magnetic cut-outs for use in secondary distribution circuits should have double poles, and arranged to act at 25 per cent. above the normal current, and be placed as near the entrance of the primary conductors into the building as possible.

Rule 24.—Where incandescent lights are run on arc light circuits, fastening or attaching lamps to any gas or other metallic fixture which may be in electrical connection with the earth is prohibited.

Rule 25.—Distributor boxes from arc light circuits must be convenient for access, kept free from moisture and dust, and as far removed as is possible from other electrical devices—pipes, metal, &c.—or earth connections.

Rule 26.—Distributor boxes must not be placed in any circuit wherein the E.M.F. of the current transmitted exceeds 1,000 volts.

Rule 27.—Distributor boxes must be arranged to automatically cut out the arc current should any defect arise or accident occur either in box or incandescent circuit.

Rule 28.—In working distributors an ampèremeter should be included in the circuit and connected with an audible alarm, so that warning will be immediately given should the current exceed the standard amount.

Rule 29.—All switches, cut-outs, safety fuses, resistance boxes, distributors, regulators and the like should always be mounted on a non-combustible insulating base. Their contact surfaces kept bright and movable parts examined at least once a day.

Rule 30.—All switches must be quick in action and arranged to simultaneously make or break at both poles. Lapping connections and rubbing contacts are to be preferred.

Rule 31.—Arc lamps should never be employed in factories where there is fine dust, as from flour, pulverised cork, or similar substances floating in the atmosphere.

Rule 32.—The frames and other exposed parts of arc lamps should be properly insulated from the circuit. Each lamp must be provided with a proper hand switch; and wherever it is possible that an excessive current may be thrown on to any one lamp or series of lamps, automatic shunts or switches must be provided for each lamp, to prevent all possibility of the forming of a dangerous arc.

Rule 33.—Arc lamps should be provided with means to prevent the carbons from falling out should the clamps fail to hold them.

Rule 34.—Arc lamps must have globes closed at the bottom; and wherever they are placed in proximity to any combustible material, like draperies, goods in show windows, flyings in frabic factories or in wookworking establishments, they must be provided with very high globes or spark arresters, and the globes be surrounded by wire netting to prevent the falling of a broken globe. Broken globes must be placed at once.

Rule 35.—Incandescent lamps should in all cases be mounted in sockets which effectually conceal the terminal connections. Safety plugs will not be allowed in lamp holders.

Rule 36.—No dynamo or other source of electricity or motor should be placed in any room of any cotton, woollen, flax, jute, or flour mill, or similar mill of like description, excepting in the engine room thereof, and where it is necessary to locate a dynamo or other source of electrical energy or motor in a dangerous position; such generators or motors should in all cases be housed, and special permission must in all such cases first be obtained.

Rule 37.—Dynamos, generators, and motors in all cases should be placed on dry foundation and preferably raised from the floor by means of insulating skids. They should be kept free from accumulations of oil and dust. A main switch should be placed at or near the dynamo or motor.

Rule 38.—Dynamo-electric machines should in all cases be provided with an automatic governing device capable of controlling any change in the current.

Rule 39.—Storage cells should in all cases be arranged with a space of 1 inch between the cells, on insulating supports and in a dry place, a metal tank or tank lined with metal placed under them to catch any leakage. They should be kept free from moisture and dust, and preferably should be enclosed in a box provided with holes for the escape of gas.

Rule 40.—Suitable safety strips should be located in the leads conveying the charging current to the storage battery, and in circuit from storage battery to translating devices. Switches should likewise be placed in both circuits. Magnetic cut-outs may be employed in place of fusible strips.

Rule 41.—All circuits should be tested at least twice a day with some approved apparatus designed for that purpose, in order to discover any ground connection or escape that may exist. A record of these tests should be entered in a book provided for this purpose and a transcript thereof furnished to the proper authorities once a week.

Rule 42.—When secondary generators or transformers are employed, they should preferably be located exterior to the building in a specially prepared fireproof structure which should be perfectly dry. Where necessity requires that they be within the building, they should be housed in a dry wooden room lined with asbestos board; a cut-out should be included in the primary circuit, adapted to act at any increase of 25 per cent. above normal current. A warning or danger sign should be placed upon the door of such housing. When electric light or power circuits are intended to be constructed, full particulars of the proposed installations and all details must be given in writing to the proper authorities. This must be accompanied by samples of the conductors with a statement of the maximum current which it is designed to send through each. Samples of the cut-outs, switches, fusible plugs should likewise be submitted unless they have previously been approved. The signing of these rules and regulations by any electric lighting power or other company transmitting electric currents shall be considered as a guarantee on their part that they will faithfully observe all the conditions and make such reports as are therein provided.

II. Rules to be Observed in Locating and Constructing Aerial and Underground Conductors.

Rule 1.—Conductors conveying currents having an E.M.F. of over 50 volts, where carried through cities or closely settled localities, should in all cases be insulated.

Rule 2.—Conducting wires over buildings must be located at least 7 feet above the roofs and also high enough to avoid the ladders of the fire department.

Rule 3.—Conductors conveying currents for arc light or power, secondary distribution or the like, and when run parallel with telegraph or telephonic conductors should in no case be nearer than 10 feet where single and 6 feet where double. By double is meant outgoing and return leads.

Rule 4.—Conducting wires must be secured to insulating fastenings and covered with an insulation which is waterproof on the outside and not easily worn by abrasion, and where wires are passed through walls, cornices, or the like, should be protected as in Rule 9.

Rule 5.—Conductors carried along the exterior walls of buildings should in all cases be supported upon glass insulators placed at least 10 inches apart and so arranged as not to be liable to abrasion from cornices, metallic shutters and the like. Special means should be provided to prevent accumulations of ice upon such conductors.

Rule 6.—Conducting wires conveying currents such as employed in electric lighting and power, and which are in proximity to other wires, should be so secured or guarded as to prevent any possibility of contacts between the wires in case of accidents to the wires or their supports.

Rule 7.—All conductors carried underground should be encased in lead and preferably located in conduits made of a material which is non-porous to gas or water, non-inflammable and of good insulating character.

III. Rules to be Observed to Prevent Accidents to Life.

Rule 1.—No work of any sort, kind, or description should be done upon an electric circuit whereon the E.M.F. of the current flowing exceeds 50 volts for alternating currents and 200 volts for continuous currents.

Rule 2.—Where it is necessary to repair any portion of the line or fixtures, lamps, or other translating devices contained therein or thereon, and the current be flowing thereon, such portion of the line or fixture must first be cut out of circuit by means of a suitable cut-out which shall be in electrical connection with a visual or audible telltale device to show or make evident by sound that no current is flowing on the line.

Rule 3.—Where bare conductors are employed for the transmission of power they should rest upon insulating supports and be provided with an insulating covering for at least 2 feet each side of the support.

Rule 4.—Long lines having a number of arc lights in series should be provided with a shunt and suitable cut-out switch around every five lamps.

The Gaulard-Gibbs Transformers.—The New York *Electrical Engineer* reproduces in the December issue the specification forming part of Letters Patent, No. 351,589, dated October 26th, 1886, to Lucien Gaulard and John D. Gibbs, assignors to George Westinghouse, jun. The claims of this specification were lately published by us, but we now learn that they were refused by the Primary Examiner on the ground of lack of patentable novelty, but allowed on appeal to the Board of Examiners-in-Chief. From this Professor Silvanus Thompson will see that at least one man in the American Patent Office has the courage of his opinions.

SOCIETY OF ARTS.

Motors for Electric Lighting.

The council of the Society of Arts are prepared to award two gold medals and four silver medals for prime movers suitable for electric light installations.

The medals will be awarded on the results of practical tests, the conditions for which are as follows:—

1. The motors will be divided into two classes, A and B. One gold and two silver medals will be awarded in each class.

(A.) *Motors in which the Working Agent is also Produced.*

Steam.—Ordinary portable or semi-portable non-condensing engines. Ordinary portable or semi-portable condensing engines.

Gas.—Coal gas or water gas with producer. Petroleum vapour. Liquid petroleum.

(B.) *Motors to which the Working Agent must be Supplied.*

Steam.—Detached engines, non-condensing, without oilers. Detached engines, condensing, without boilers.

Gas.—Engines worked by illuminating or other gas. Engines worked by raw gas without producers.

Hydraulic.—Water motors.

2. Each classs will be subdivided into two groups—those declared to develop not more than 10 H.P., and those which will develop more than 10 H.P. and less than 20 H.P.

[The horse-power herein mentioned is equivalent to 33,000 lbs. raised one foot high in one minute, as measured on the brake.]

3. The entrance fee will be £2 10s. per H.P., to be paid on entry.

4. No competition will be held unless 10 motors at least are entered.

5. In case of no competition being held, the entrance fee will be returned.

6. The council reserve the right of refusing any entry.

7. All engines and boilers must be fitted up in accordance with the regulations of the Royal Agricultural Society, viz.:—

a. All boilers must be fitted with a steam pressure gauge. Before any engine can be worked, the pressure gauge must be verified by the judges.

b. There is no restriction as to the construction of steam engines or boilers, but the judges must be satisfied that the bursting strength of the engine or boiler is at least four times its working pressure, and that a hydraulic test of one and a half times the working pressure has been satisfactorily applied.

c. Each exhibitor must declare the greatest pressure at which he proposes to work his boiler or engine.

d. No old boilers, that is boilers that have manifestly been at work for a considerable time, will be admitted without special thorough examination and a certificate of safety from the judges.

e. Each boiler, of whatever form or size, must be provided with the following mountings:—*Two Safety Valves,* each of sufficient size to let off all the steam the boiler can generate, without allowing the pressure to rise 10 per cent. above the pressure to which the valve is set. *Two Sets of Gauges* for ascertaining the water level. *One Steam Pressure Gauge,* which must be tested and verified by the judges before the boiler can be used. *A Half-inch Cock,* terminating in a half-inch male gas thread, for the purpose of receiving a testing pump. *One Check Feed Valve,* immediately attached to the boiler, in addition to the ordinary pump valves, whenever the feed is introduced below the lowest safe water-level, or where there is a length of feed pipe between the engine and boiler.

f. Exhibitors must be provided with all the appliances necessary for taking the working parts of the machinery to pieces, for examination, should the judges require it.

g. Shafting, belts, gearing, high-speed machinery, and any other exhibits likely to prove dangerous, shall be securely fenced and protected to the satisfaction of the judges, but such approval shall not relieve the exhibitor from his own liability.

8. The points of merit considered of the greatest importance are:—*a.* Regularity of speed as to revolutions per minute under varying loads. *b.* Regularity of speed during the various parts of one revolution. *c.* Power of automatically varying speed to suit arc lights. *d.* Noiselessness. *e.* First cost. *f.* Cost of running. *g.* Cost of maintenance.

9. The tests will be carried out under the direction of three judges appointed by the Council of the Society of Arts, who will report to the Council, and will confer with them on the awards.

10. The Council will publish the awards in the *Journal* of the Society of Arts. They reserve the right of publishing descriptions of any of the motors, and the competitors must afford every facility for this purpose.

11. The competitors must take upon themselves, in exoneration of the society, all claims in respect to damage (if any) resulting from the testings, and must renounce all claims for compensation for any injuries, real or imaginary, that they may incur from alleged or actual imperfection in the testings, or from any statement in the report or description published.

12. The competition will take place in London about May or June next. Entries must be sent in by the 28th February, 1887.

13. All costs of fitting up and working the motors must be borne by the exhibitor. The society will provide the brakes, indicators, and apparatus, electrical and other, necessary for making the tests.

14. The Council reserve the right of withholding any or all the medals.

GLOW-LAMPS: THEIR USE AND MANUFACTURE.*

By MAJOR-GENERAL C. E. WEBBER, R.E., C.B.

IT is not my intention to enter into any dissertation on the various kinds of glow or incandescence lamps which have appeared from time to time since their first use by De Moleyns, Starr, and King, between 1840 and 1850, nor do I wish to trouble my audience with the history of the inventions which have led up to the so-called glow-lamp now in commercial use. It is my desire to lead them to realise that in the manufacture of glow-lamps we have a rapidly growing industry, in the increase and efficiency of which they may all before long be interested. It is true that the time has not yet arrived when a general audience can be expected to evince as much interest in my subject as they would naturally do in the lectures on candles or lamps, delivered in this hall, but it is believed that a more general knowledge of this very interesting subject will aid in its popularisation.

When the glow-lamp was first introduced, its promoters misled the public judgment and eye by claiming for it more duty than it was able to perform. It was shown in exhibitions, where each exhibitor vied with the other in one direction, namely, in creating a blaze of light, where the little glow-lamp was placed alongside the powerful and intense briliancy of the arc electric light. The exhibition of lamps of 16 to 20 candle-power in groups became the custom, and the public was unconsciously led to compare these, in their minds, with gas jets and Argand burners of far lower real candle-power.

Born and educated in the use of illuminants, which present to the eye a soft wide gaseous flame, having a measurable iridiscent surface containing incandescent particles widely dispersed, we were quite unprepared to estimate the increased power of the brilliant little line of intense incandescence that meets our view when we regard this glow-lamp.

Wherever one went, either the gasfittings were made the supports of the glow-lamps or it was hung from the ceiling, so that on entering a room lighted by a number of these pendants, a brilliant line of light cut the eyes like the blow of a whip lash, rendering everything for a time obscure. Indeed, from careful study of places lighted with the glow-lamp, I have come to the conclusion that the eye is much longer recovering the effects of this sudden slight paralysis of its light receptive powers than is supposed, and that this cry of more light which one hears, where the subject has been dealt with from a gasfitter's point of view, is simply due to temporary observation and loss of power to discover the true needs for illumination of the surrounding objects.

In more than one club in London, where the lines I have referred to have been followed in applying electric light, although the candle-power of the latter is about three times the value of that of the lamps previously in use, there is a constant outcry from the young eyes that "there is not enough light," and from the old eyes that "they know not where to go to avoid the glare."

When regarding this question from the point of view of economy, we see the reason why the cost of electric lighting has so much deterred its use in competition with cheap gas, at the same time the still cheaper arc electric light is ignored or condemned. The screening of glow-lamps from direct vision adds still further to the cost of lighting, but if arc lamps were more used, their cheapness would allow of much light being wasted in concealing their brilliancy by deriving the light only from reflecting surfaces.

The conclusion I have come to, after visiting electric light installations at home and in many parts of the Continent, is that with all kinds of elactric lamps used in interiors, the eye ought never to be allowed to meet the source of light, even when subdued 30 per cent. by transmission through obscuring media.

Lately, the Council of the Royal Albert Hall has been making a few experiments in the distribution of light within that noble building. Both arc and glow-lamps have been tried. The former in the upper, the latter in the lower part of the hall. With the arcs, it was found that only in the upper arcade could they be concealed from the eyes of the audience. The effect of brilliantly lighting it up with 12 2,000 candle-power arcs was good, but the light reflected into the body of the hall by the back wall, was probably only one-tenth of that yielded. Six more such lamps placed high up in the lantern, were of no more use than moonlight would have been, but when lowered below the level of the cornice, gave directly or by reflection their full effect. When all the 18 were suspended in a group and let well down into the body of the hall, the illuminating effect on objects was inferior to that of the 32 gas pendants, each with 60 gas jets, which are suspended all round the hall just above the arcade, but when one turned the back to the light the same print was equally easily deciphered.

What the effect of diffusing the light of such a group would have been if the lamp had been confined in an obscure glass lantern remains to be proved. Advocates of concentration and of dispersion of the arc lamps were found. But when it came to the concentration or dispersion of the glow-lamps used in the trial, there was little difference of opinion as to the good effect of throwing the light from them towards the backs of the boxes by placing them under the ceilings of each box, and concealing them from the eye of the audience. Some will recall the gloomy cavernous effect of the three tiers of boxes at the Royal Albert Hall. Lighted up, as some of them were, for the trial I am describing, the scene was pronounced fairy-like. The lights were placed so as to be of no inconvenience to the occupants; but the effect was to lighten the whole aspect of the elevation, and as every lamp was concealed, the eye could dwell on features of construction and colour, which before were no more than masses of shade.

This concealment of the glow-lamps was also carried out on the orchestra stage under the organ, where the trial was equally successful in demonstrating the fact that, although the loss of light may be considerable, by following such a course that loss is a gain, when it can be proved (of which there is no doubt) that the eye is far better able to examine the objects around the concealed lights than if they were exposed.

From the manufacturing point of view, the glow-lamp consists of three distinct parts, namely:—The filament; the wire mount or conductor; the glass bulb.

The object of most inventors has been to find a highly refractory substance, and they have all ended in using carbon of either a fibrous or morphous consistency, which they produce in the shape and of the nature which they require, by various processes. The conditions of form, density, uniformity of section, surface, and electrical resistance, with which a glow-lamp bridge must be endowed are now well understood.

So early as 1878 it was discovered or revealed, that in order to be able to use a large number of glow lamps on one system, they must all be subject to the same electrical conditions of tension. It was found that it would be impossible to maintain uniform illumination in all the glow lamps on a system, if each lamp was to be subject to different conditions of pressure; and that the only way to achieve a practical result was to connect one terminal of all the lamps to a main conductor conveying a current in the first place sufficient for all the lamps destined to be used in the system, and in the second place having an E.M.F. or potential above zero (zero being an empirical "earth,") of an energy suitable to bring the filament to a state of incandescence; and so arrange that the value of the E.M.F. should be the same throughout. In other words, the system of distribution known as the parallel system was thus practically discovered. The second or return conducting path is, of course, necessary when dealing with a physical development of energy such as what we call "electricity," to complete the circuit to the so-called negative terminal of the dynamo, or other source.

It will readily be appreciated that the word "parallel" is a misnomer, the parallelism of the conductors having nothing to do with efficiency. And that their being carried alongside of one another throughout a building only arises out of a desire to economise the labour of the workmen who have to put them up.

It would, I conceive, be well if the public, and above all the insurance companies (for it is largely a question of fire risk), could be brought to understand that the second or return wire is electrically the same as the "earth" of the electrician, and that so long as the positive, or supply wire, is well insulated and kept far apart from the negative, or return wire, no further precautions are necessary; and when they are thus far apart, even if one is bare, greater security is obtained than by the present system, which unreasoningly insulates the wire which need not be in a state of electrical tension, as well as that which is always ready to discharge. I have digressed a little way to show why absolute uniformity in the glow lamps is necessary to such a system; nothing in its condition could be made to compensate for any defect in that respect. The chief aim then must be to secure this uniformity in the manufacture of the filaments of glow lamps.

In a good glow lamp, inseparable from uniformity of resistance, are uniformity of surface and incandescence. Uniformity of resistance when hot, means that each lamp will (so to speak) consume the same amount of current, and this can only be secured by electrical measurement under the conditions of uniform electrical pressure. Uniformity of incandescence and surface means that lamps possessing these qualities give almost the same candle-power, and this can only be obtained in the manufacturing processes by visual measurement.

To secure all three, it is necessary to combine a means of visual and electrical measurement. The former is but approximate, the latter is as accurate as a Thomson's galvanometer can make it. In either case, however, when large numbers of filaments have to be standardised, neither measurement can be expected to produce greater accuracy than is essentially necessary for a good commercial lamp; and the fact is that while uniformity of E.M.F. is the condition which must not be departed from, no harm arises in practice if the current consumed and the candle-power is not absolutely uniform. Thus, the required resistance of each lamp is such a resistance as will, under the condition of uniform E.M.F. or electrical pressure, give, with a small varying area of surface, such a candle-power as that to the eye all the lamps are alike when they are incandesced.

This required resistance is obtained by a process known in the electrical world as "flashing," a title which, I believe I am right in stating, owes its origin to Mr. Lane-Fox.

The filaments having been thus standardised, they have to be mounted or attached to the metal conductors, which pass through the glass, and thus make their ends electrically in communication with the outer air. An important condition of the result of any process of doing this must obviously be the obtaining of a good and perfect electrical contact or joint between the metal and the carbon. The absence of this would be fatal to the future of the lamp. Every inventor has laboured hard to secure this.

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* Abstract of paper read before the Society of Arts, Wednesday, December 8th, 1886.

The making of good joints between the ends of electric conductors has been, for the last 30 years, the subject of intense care to every engineer who deals with electricity. No wonder that its importance should be vital in the case of these two little connections, knowing that once sealed up in this bulb they cannot be got at again for repairs, and also knowing the intensity of the current to which they must be the path. In joining iron or copper wires to one another, telegraph engineers long ago knew the difference in the resistance of their lines due to the careful use of soldered joints, instead of leaving them what they call "dry."

Next is the question of the solder to be used, and I believe that no one will dispute that Mr. Lane-Fox was the first to use the process of deposition of carbon by electrically heating the joint in a vessel containing an hydro-carbon surrounding, so as to solder the metal and carbon surfaces to one another. The way in which this is effected is pretty much the same in execution everywhere.

The wire mount of platinum wire, or other suitable metallic conductor, is placed in contact with the carbon filament or bridge, so that they are kept together by any suitable contrivance of their ends, and the joint is then flashed. As any further deposition of carbon on the filament itself would alter the standard effected in the previous stage of the process of carbonisation, it will not answer to allow any current to pass through it. This is prevented by any simple means of short circuiting the current, so that it shall only pass through the joint. In the process carried out before you, this is done by this apparatus, which holds the filament in this vessel, which contains hydro-carbon in a liquid instead of in the gaseous form you saw used for carbonisation in the previous stage.

Practically, the chemical phenomena are identical in each case, and the result in this one is a perfectly homogeneous electrical joint, larger in section than the other portions of the path of the current, and therefore of ample strength and conductivity to prevent risk of any future wear and tear through high temperature and rough usage.

There is not much to be said about the platinum mount. There are small details in its construction, and the manner of preventing its two sides coming into contact, which vary little in design, and all have the common object. You now see this done by the introduction of the little glass bridge piece. The platinum which should be used, its homogeneity and physical conditions, are all objects of experiment and great care, too minute with which to trouble this audience.

THE BULB.

Having completed this important factor in the construction of a glow lamp, let us turn to the envelope, or bulb, which is destined to be the home of the burner, under conditions for supporting combustion opposite to those under which any other means of illumination will act. In the latter, the presence of oxygen in due proportion to the supply of hydro-carbon and other light-yielding gases is vital to its usefulness. In the former, the presence of oxygen within the bulb, and its contact with the carbon bridge, is rapid death, instead of the slow decay, ending in extinction, which is the best that as yet can be expected from the glow lamp. Imperfect though it may be, it is, however, very good, and not likely to be superseded.

This little glass vessel has also its stages of manufacture, as you will see by the performance in your presence, the power of demonstrating which, together with the processes previously shown, I owe to the permission of the Board of the Anglo-American Brush Electric Light Corporation, whose factory and offices are situated on the Surrey side of the Thames, just over against Charing Cross.

The last stage, namely, the exhaustion, is probably that upon which the life of the lamp most largely depends. This process, exemplified by the action of the mercury pump which you see here, is apparently a very simple one, and would be so, were it not that there are several small impediments to success which, when one comes to demanding a vacuum of one-millionth of an atmosphere, are very serious difficulties.

In the first place, great attention must be paid to the construction of every part of the pump, for, with valves or taps of the ordinary kind, inevitable failure and waste of labour would ensue by leakage when the stage of high vacuum is being approached.

I will avoid going into any description of the merits of the various forms of mercurial air pumps, because Prof. Silvanus Thompson will before long read a paper on that subject before this society.

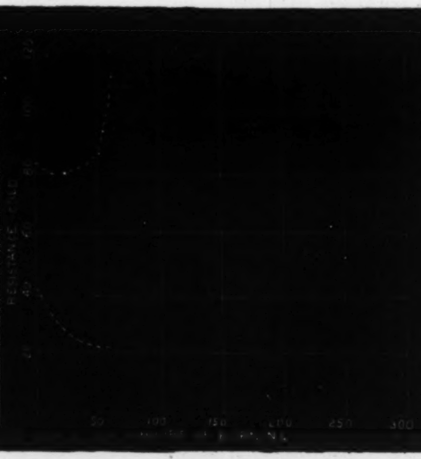
The best vacuum test is probably that which is made electrically. This is carried out with an induction coil of very high tension, and the test consists in observing when the sparks between two poles of platinum, placed in a part of the pump which shares the vacuum with the lamp under treatment, travels outside the glass instead of inside.

The process of exhaustion in the early days of glow lamp making occupied three or four hours; now it has, by better appliances, been reduced in time to a little more than half-an-hour. The number of lamps turned out in a factory is determined by the number of lamps on each pump, generally three or four, and the number of pumps. Allowing ten removes a-day and twenty-five pumps, each having four lamps, a manufactory could turn out 1,000 lamps a-day. The lamps are next tested and classified for candle-power and voltage, and marked accordingly: formerly 50 per cent. failed to give the standard of efficiency in those respects, now all are up to the mark within 10 per cent.

The electrical efficiency of lamps is measured by the watts expended per candle-power. As is well-known, economy in this direction effects a saving for a given amount of light required on an installation of electric lighting, in power converted into electricity, and in the size of the conductors which convey it to the lamps.

Most makers' lamps vary between 3 and 5 watts per candle-power, when the lamps are new, under the conditions of voltage which gives the longest life. Those are alleged to be as follows:—Edison, 5 watts; Swan-Edison's, between 3·5 and 4 watts; Victoria, 3·5 watts; Woodhouse-Rawson, 3·0 watts.

The scientific man does not require to be told what are the tests to which he should subject glow-lamps to prove their efficiency. At the Crystal Palace Exhibition, at Vienna, at the Health Exhibition, and at Philadelphia, very exhaustive tests were applied to the lamps of several well-known makers; but, at the best, all these have proved unsatisfactory, because the makers themselves were not likely to contribute their average lamp, and and in some cases either declined to contribute at all, or repudiated the results after they were published.

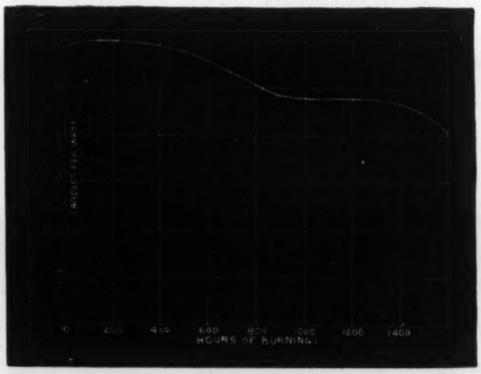


CURVE 1.

Showing relation of resistance (cold) of various glow lamps at different periods of their existence.

The tests which require apparatus not usually outside a laboratory are those which observe the E.M.F., the current, the resistance, and the watts per candle-power. There are various arrangements for testing candle-power. I am indebted to Dr. Fleming for that which is shown on the diagram.

The arrangement is a very special one for securing an accurate E.M.F. in the lamp in process of testing, The disc of a photometer is fixed, instead of, as is usual, being left free to slide. The standard flame is a lamp of burning pear-oil, or acetate of amyl, with a flame of regulated height. The lamp to be tested is placed on a carrier which slides along the scale bar.



CURVE 2.

Showing variation in efficiency of glow lamps at different periods of their existence.

First, to test the current. The current which feeds the lamps passes along the mains plus and minus, *viâ* the minus through a Thomson's graded ammeter and a platinoid resistance to one terminal of the lamp. The difference of potential between the termini of the coil is compared with the E.M.F. of a standard Clark's cell on a potentiometer. This latter is a perfect check on the accuracy of the ammeter.

Second, to test the working E.M.F. at the termini of the lamp. Similarly this is made with a Thomson's balance voltmeter, as well as a Thomson's grade voltmeter, checked by measuring the difference of potential at the extremities of a 100 ohm coil in series with a 10,000 ohms coil.

The voltmeters themselves are placed between the terminals of the lamp, but by means of the resistances, the potentiometer with a Clark's standard cell is only compared with $\frac{1}{1000}$th of the E.M.F. of the lamp.

It will be understood that the standard cell in each is the ultimate check on the measuring instruments, provided the resistances are perfectly true, and if the latter do not agree with the former, they have to be re-calibrated.

The need for standardising the measuring instruments used by electricians has been pressed home by Dr. Fleming to the conviction of every one concerned, but up till now little has been done beyond deliberation by a committee of the Society of Telegraph Engineers and Electricians. At present we do not know that we all mean the same thing when we speak of some of these units of measurement.

Users of glow-lamps will be interested in the table shown, which is an average of several tests of the lamps of two or three makers:—

Mean current and candle-power of two long-lived 100 *volt* 17-*C.P, lamps of different makers, run at* 100 *volts, and tested every* 100 *hours.*

	Initial	current		=	·63 *a*	C.P.	=	18·5*
After	100	hours	,,	,,	·65 *a*	,,	,,	18·8
,,	200	,,	,,	,,	·65 *a*	,,	,,	20·7
,,	300	,,	,,	,,	·65 *a*	,,	,,	18·5
,,	400	,,	,,	,,	·65 *a*	,,	,,	18·5
,,	500	,,	,,	,,	·65 *a*	,,	,,	18·5
,,	600	,,	,,	,,	·65 *a*	,,	,,	18·
,,	700	,,	,,	,,	·65 *a*	,,	,,	17·5
,,	800	,,	,,	,,	·64 *a*	,,	,,	15·5
,,	900	,,	,,	,,	·64 *a*	,,	,,	15·2
,,	900	,,	,,	,,	·64 *a*	,,	,,	15·2
,,	1,000	,,	,,	,,	·64 *a*	,,	,,	15·2
,,	1,100	,,	,,	,,	·64 *a*	,,	,,	15·2
,,	1,200	,,	,,	,,	·64 *a*	,,	,,	15·2
,,	1,300	,,	,,	,,	·64 *a*	,,	,,	15·2
,,	1,400	,,	,,	,,	·64 *a*	,,	,,	15·2
,,	1,500	,,	,,	,,	·63	,,	,,	13·7
,,	1,600	,,	,,	,,	·63	,,	,,	12·7†

This gives a little history of the changes of the filament during its life. The tale told may be summarised as follows:—That during the first 200 hours the resistance decreases slightly, with consequent increasing brilliancy. These conditions remain nearly stationary for the next 500 hours. After that they alter perceptibly, increasing in resistance and decreasing in brilliancy in a progressive ratio. But it must not be forgotten that the increase in resistance of the filament is not the sole cause of the loss of light. As the filament ages, its original smooth surface roughens, and is consequently increased in area in larger proportions than it would naturally be decreased by the loss of bulk. The larger surface requires more current, whereas the increased resistance is gradually reducing the supply.

Another cause of the loss of light is due to the blackening of the glass by a carbonaceous deposit, which also increases with age. This latter loss in 1,000 hours' consumption amounts, in a good lamp, to 15 per cent. This clouding over of the lamp bulb is due to an internal deposit due to the disintegration of the material, either of the wire mount or of the filament.

Dr. Fleming gave the Physical Society, in 1883 and in 1885, a description of some curious phenomena incidental to this aspect of the use of glow-lamps. It is sufficient to our purpose to mention the cause and the effect.

As time goes on in the life of a glow-lamp a smoky deposit is apparently inevitable; but, quoting Dr. Fleming, "In normal use, when the lamp is not being pressed beyond the E.M.F. at which it is intended to be used, there is a general evaporation of carbon going on from all parts of the loop."

His experiments tended to show that when an excessive temperature is given to the filament by a higher E.M.F., the molecules are projected with violence against the glass, causing by the more rapid disintegration an earlier obscuration of the globe than should arise under normal conditions of consumption. The rate at which the clouding takes place is rapid in the case of some defective filaments. But as a rule makers have conquered this difficulty, and it takes place under conditions which are preventable. The loss of light is very slight, and the appearance of a clouded lamp by daylight is, I think, its most objectionable feature.

Any user of glow-lamps on his own installation will find, when he replaces old ones by new, that the latter will give more light, so that, if he introduces a new lamp to replace one which has been broken at a period when most of the lamps are, say, 900 hours old, he will perceive a difference of about two or three candles if he uses seventeen candle-power lamps. If the old lamps are, say, 1,700 hours of age, he may find a difference of seven or eight candles. As the current is not economised in proportion to the loss of light, he should recollect that a point may be reached when, by continuing the use of old lamps, there arises an important waste of power. Hence the public should judge of the efficiency of lamps, outside certain limits, more by their constancy of candle-power rather than by their length of life, Thus the best lamp is that which lives the longest with least variation of light.

Next we may consider the test for vacuum, which in a laboratory can be made with the induction coil as already mentioned by the following test:—Hold the lamp in one hand, and bring the leading in wires in proximity with the pole of a high potential induction coil. If the vacuum is bad, a considerable glow is visible inside the bulb; if good, the glow decreases, and will be evidenced by the length of the spark between the coil and the wires, so as to be almost invisible, and the spark outside is very faint and short.

The vacuum test may also be made by the measurement of heat, to which a lamp burning for a given time will raise a given volume of water in which it is immersed, but this test has one defect.

Another, but a rougher test, is one which is made by sealing off the lamp with a short length of the vacuum tube attached, and then cutting or breaking its end under mercury, when a bubble denoting the presence of air if it exists will be detected as soon as the mercury has risen into the bulb.

The users may make an approximately good test, by observing the presence of luminosity when a lamp is rubbed with the fur of a cat's skin in the dark, or by the touch. The temperature of the external surface of the bulb after it has been alight an hour or so, will show undue heating which will signify the existence of a bad vacuum.

The scientific test of the candle-power of these lamps involves us in the form of photometer to be used, and above all the standard of light. The latter is a question which is still under the consideration of a Committee of the British Association. It appears to me that it is not much nearer decision than it was when brought before the Congress of Electricians, at Paris, in 1882, when the Carcel lamp and the candle still had their supporters, but there may be members of the committee present who can enlighten us thereon.

For manufacturing purposes it is the practice, as I have shown is done by Dr. Fleming, to use standard glow-lamps, which are frequently renewed before they have time to deteriorate. These standards are obtained by photometric comparison with flames or sections of flames of known value; ultimately referable to an average of a series of tests with the standard sperm candle. But when it comes to competition tests between the lamps of various makers, that which is most relied on is the life test, for although that test is also a trial of the carbon, it is now generally understood that most fairly well constituted filaments, will live in a really good vacuum.

To consumers the life test is a matter of economy. They can easily be brought to understand that if their lamps are used with a higher E.M.F. than that for which they were made, over-incandescence takes place, as well as the "clouding" already referred to. This is commonly called "overrunning" lamps, and it is very easily brought about by want of arrangement at the source of the current to secure regulation of the pressure. Often the purchaser of lamps condemns them for their short life, not knowing that all along it his own fault, and that through frequent over-incandescence, his eye has lost the power to judge, even approximately, of the candle-power he is extracting from them. It is not to be expected that he should have a photometer in his house to check this, but it is not too much to require him to have a voltmeter at a point where he may occasionally test for himself, whether the potential between his mains is dangerous to the endurance of the filaments in his lamps. If, however, his lamps behave as those did as shown in the Table already mentioned, he should observe his voltmeter with the view to underrun them in adolescence, so that a healthy maturity and vigorous old age may follow.

There are those present to-night, I believe, who can give the audience very interesting information on these matters.

In some lamps, defective cementation of the filament to the wire mount, shows itself after a short life, by a giving way or a fracture at that point; but no eye test can, beforehand, detect the liability to this fault. It is said that there is a greater tendency to give way the junction with the negative metal pole, and from this it has been suggested that when alternate currents are used, their liability to failure would be modified. It will be very instructive if some one of my audience can enlighten us this evening as to the effects on filaments by the use of alternating currents.

Time does not allow of my touching on several points of interest in connection with glow-lamps, brought before electricians in late years by Mr. Wilhelm Siemens, of Berlin, by Cruto, of Milan, and by Bernstein in this country.

I trust my audience will realise that my object this evening has not been to enter on too technical or debateable ground, but rather to engage their interest in the subject from its industrial point of view; and that they will also look with approval on my abstention from touching on the patent and legal part of the question, which has so long been, and still is, a matter of controversy.

DISCUSSION.

The Chairman (Prof. W. G. **Adams**, F.R.S.) said General Webber had done well in bringing before the Society of Arts the special points of interest and importance in connection with the use and manufacture of glow lamps. It might not be amiss, as a matter of history, to draw attention to the characteristic curves of different glow lamps, and to the state of knowledge which existed on the subject in 1882, when a complete series of tests were made at the Crystal Palace Exhibition. The tests made on this occasion were represented on the diagram on the wall, the curves representing the different incandescent lamps, namely, Swan, Edison, Maxim, the British, and the Brush electric lamps. The candle-power, and watts per candle, were also given. The best result attained at that time was four watts per candle, by two kinds of Swan lamps, the high resistance, and the small eight or ten candle lamp. Next to that came an Edison, which took nearly five watts per candle, and then the others, in the order named. He did not think electricians would approve of the use of earth in place of the insulated wire to the dynamo, as suggested by General Webber. Surely this would be an element of disturbance, and of considerable danger in the case of machines of high potential.

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* 3·4 watts per C.P.   † 5 watts per C.P.

Mr. W. H. Preece, F.R.S., said one of the most important points which had been dwelt upon was the life of the lamp, and the various improvements which had been made during the last few years to secure this extra life, but he did not think they could congratulate themselves upon the longer duration of the lamp. His own complaint was that the lamps were too long lived. In 500 hours a 16-candle lamp descended to about 8, as a rule; what was wanted was a lamp which would maintain constancy, and there was no mode of attaining this more effective than the use of secondary batteries. It was not possible for any isolated installation to be effective or complete unless there were secondary batteries, as had been fully demonstrated in the lighting of the room in which they were now assembled. The amount of money saved in renewing the lamps alone would repay the interest on their cost. With regard to the manufacture of glow lamps, it could not be denied that this was increasing very fast; only the other day, he heard that at Edison's factory they were turning out about 3,000 a day: and from a rough estimate which he had made, he found that during the last four years the manufacture had increased so fast, that probably at the present moment 10,000 lamps were made daily, as compared with ten a day four years ago. He did not agree with the chairman in his condemnation of of the use of earth, nor did he understand General Webber to advocate the use of earth, but only to speak of the use of the return wire in the electrician's meaning of "earth."

Dr. Fleming said an incandescent lamp was not only a useful thing, but it had about it many points of great interest in physics. Many persons had the impression that the interior of a glow-lamp was a place that was empty of all air particles, but this was not the case, it was as full as it well could be. Maxwell had shown that in a small cube of 100,000th of an inch, there would be found 100 million molecules of ordinary air, so that in a cubic inch of air there were a number of molecules represented by 100,000,000,000,000,000. In a Swan lamp, when exhausted to one-millionth of an atmosphere, there remained some 400,000,000,000 molecules of air. As it took about ten days to count a million, a simple calculation would show that to count the number of molecules in such a vacuum would take 120,000 years of continual counting. The fact that the glow lamp was as full of molecules as it well could be led to many interesting consequences. The atoms were, however, so far apart, that any one of them could go from one side to the other without coming into collision. In an ordinary glow lamp when burning, from all parts of the carbon filament molecules of carbon were being thrown off by the heat, which gradually produced the cloudy appearance that was sometimes seen. If this went on equally, the darkening was equal, but in a glow lamp the heat was greatest where the resistance was greatest, so that if by accident, on any part of the filament there was a spot of greater resistance, the scattering of molecules would take place quicker at that part, and the filament would be cut through. The greatest projection of molecules would take place to the parts of the glass which were not shielded by tho loop. He held in his hand an Edison glow lamp, clouded with transparent copper, which had been deposited from the clamps in burning. With regard to testing incandescent lamps, there was no difficulty in making electrical measurements with any degree of accuracy, but what could not be done was to measure the illumination with equal degree of accuracy. The plan of measuring glow lamps by means of candles was a barbarous one, and ought to be got rid of, as a standard candle would vary to any extent up to 20 per cent. Therefore, until they got something more accurate as a standard light, research could not be pushed forward with any degree of accuracy. A suggestion was made at the Paris Exhibition to use melting platinum for a standard of illumination, but nothing had as yet been done in this direction. It was probably possible to use as a standard the radiation from a material such as carbon, in which was being wasted, from a definite surface area, a definite quantity of electric energy per second, and by this method they would have better means of carrying on the investigation of characteristic curves and the question of illumination. The standard which he used was Siemens's acetate of amyl lamp, which gave very fair results, and, besides this, there was Methven's gas-flame standard, and Harcourt's air gas-flame standard, which gave fairly good results.

Prof. Forbes said that various speakers had touched upon the standard of light, and General Webber had expressed an opinion that they were in the same position as they were several years ago; but upon this he ventured to differ, as he considered they were far ahead of what they were a few years back. The B.A. committee, of which he was secretary, had been carefully studying the subject, and though many thought it was a slow process of elaboration to get a standard from the gradual way in which the committee had been working, yet he believed every one would agree in the end that it was not wise to jump too hastily at a conclusion. Dr. Fleming had said that he thought a standard of light should be produced by electric energy, but there were two difficulties in the way; first, you had to know what was the temperature of your standard; two equal areas of incandescent material, might be using up the same electrical energy and yet the light be totally different; and in the second place, the whole of the energy being used up, was not utilised for the purpose of light. The question was not quite so simple as it appeared, but he hoped that in time such a standard might be obtained, though at the present moment the experiments which had been made did not tend to make them hope very much that they would be able to determine in any convenient manner the temperature of an incandescent material rendered incandescent by a current of electricity.

Professor Silvanus Thompson said he happened to know that many improvements had taken place which had not been referred to by General Webber; and in the report of a certain law suit there was reference to a mysterious process called "running on the pump." Whether the processes were universally known or not he could not say, but it was quite possible that there might be a few details which had not been revealed in the account of how glow lamps might be made. As a rule, it was found when lamps failed that it was through a fracture of the bridge just above the joint where it was cemented to the wire which led in, but very often the fracture took place not at the heel of the bridge, but just below the crown of the bridge. He should like to know why it was that this occurred; had it anything to do with the bending of the material in the process of formation, or had it anything to do with the distance between the bridge and the surrounding bulb? It had been suggested that electricity possessed a sort of inertia, and did not like to go round a bend, but he could not quite agree with this view, and should be glad of any information upon the point. He considered the use of the word "filament" for the conductor or bridge a misnomer, as it was misleading; it should be called a "strip," or a "wire." To give the new name of "filament" to that which was perfectly known before as a carbon wire or carbon strip did not constitute it a new invention, though it might be very clever to invent a new name for an old thing.

Major-General Webber said that for the exhibition which he had been able to produce that evening, the thanks of the members were due to the directors of the Anglo-American Brush Corporation, who had placed their apparatus at his disposal, and to the officers and assistants of the company for the hearty way in which they had come forward and helped him by showing so accurately and carefully the processes in which they were daily engaged. He thought the warmest thanks of the meeting were due to them, as well as to the worthy chairman.

On the proposition of the Chairman, a cordial vote of thanks was passed to Major-General Webber and to those who had assisted him in carrying out the different processes of manufacture.

INCANDESCENT LAMP PATENTS.

Court of Appeal, High Court of Justice.

(*Before* Lords Justices Cotton, Bowen and Fry.)

Edison and Swan United Electric Light Company *v.* Woodhouse and Rawson.

Monday, December 13th, 1886.

The appeal from the judgment of Mr. Justice Butt in this case, which relates to the alleged infringement of Edison's patent for incandescent lamps, has occupied the attention of the Lords Justices of Appeal since Monday afternoon. Sir Horace Davey, Q.C., M.P., and Mr. Macrory, have appeared for the appellants, Messrs. Woodhouse and Rawson; and the Edison and Swan Company has been represented by the Attorney-General (Sir Richard Webster), Mr. Aston, Q.C., Mr. Fletcher Moulton, Q.C., M.P., and Mr. P. Edward Dove.

Sir Horace Davey, in his opening, said this was an appeal against the judgment at the trial of the action of Mr. Justice Butt, sitting as an additional judge of the Chancery Division, dated May 20th, 1886, the part of the judgment which was complained of being so much of it as found for the plaintiffs; and against the consequential relief on the footing of that patent having been infringed. The statement of the action was founded upon three patents—Edison's patent, which was the one now in question, No. 4,576, of Nov. 10th, 1879; secondly, a patent originally taken out by a gentleman named Swan, which was called Swan's patent; and thirdly, a patent taken out by a person named Gimingham, all the three patents being vested in the plaintiff company. The case as regards Swan's and Gimingham's patents, was abandoned by the plaintiffs after they had opened their case, and the only part of the case left therefore, was on Edison's patent, and accordingly the judgment provided for so much of the action as related to Swan's and Gimingham's patents being dismissed with costs against the defendants. But with regard to Edison's patent, the learned judge found that the patent was valid and not open to the objection the defendants made to it. He construed the patent in a particular way, and, construing it in that way, it was not seriously disputed that the patent was infringed. He submitted to their lordships that the patent was not a good one, and that the subject matter of it was not a proper subject for a patent. With respect to the second claim, which was the one alleged to have been infringed, giving it the construction which the learned judge gave it, it was too wide, and on the other hand, if it was to be limited in a way their lordships would appreciate presently, then the defendants said there was no evidence of infringement. In fact, it was the old dilemma which so often arose in patent actions, "If you construe the patent in such a way as to uphold it, then I don't infringe it; but if you construe it in such a way as to catch me in its meshes, then it is too large." Of course, when the patentee was endeavouring to uphold the validity of his patent, he was anxious to show how extremely careful he had been to confine it within limits of moderation; but on the other hand, if he was construing it for the purpose of catching an alleged infringer, he was anxious to show how large his sweep was, and that it would even enclose in its meshes the defendants in question. The patent in this case related to incandescent electric lamps. Having pointed out the difference between arc lighting and lighting by incandescence, Sir Horace Davey stated that the scientific law relating to this subject was that the resistance to the electric current varied, other things being equal, inversely to the sectional area of the medium and directly to its length. That was to say, the thinner you got your conductor the greater the resistance, and the longer you got it the less the resistance. That law was well known before the date of the patent of Edison; that was not disputed. The law had been enunciated and put into practical application, but not in this particular form, by a previous inventor, who was well known in the electrical world, Mr. Lane-Fox: and it had also been announced by Prof. Tyndall and other scientific writers, so that there was no novelty in that fact. Sir Horace then read the well-known final specification of Edison, in which the latter claimed the invention of electric lamps giving light by incandescence. He then said that according to their (the defendants') conception the first and primary questions their lordships would have to decide, assuming that they took the same view of the construction of the second claim which the learned judge below took, was, What was a filament? One of the witnesses said it was something of a filamentary character, but that did not carry them much further. They were all agreed that a filament did indicate a certain thinness or smallness of sectional area, but the question was, What thinness, or what sectional area, would make a thing a filament? Their lordships would find, he thought, that Mr. Edison was not aware of what had been done by previous inventors, and his description of what he conceived to be the limit to which invention had gone was not altogether accurate. For instance, it was stated that a lamp in all respects similar to that which was said to be described by Edison had been manufactured by Swan himself, with the single exception that the plaintiffs said his burner was a pencil, or, as somebody called it, in the enthusiasm of the moment, a rope. It was a pencil one-twenty-fourth of an inch in diameter, and they said that was not a filament. In all other respects the lamp was similar to Mr. Edison's: it was a glass bulb containing a vacuum, and having leading platinum wires passing through it and sealed in the glass. Mr. Edison said his invention consisted first in the use of a light-giving body of what he called carbon wire or sheets coiled or arranged in a particular manner; secondly in the use of a perfect vacuum; thirdly in a method of manufacturing a carbon conductor of high resistance; and, lastly, in securing the metallic wires in such a manner as to exclude the air and using a vacuum instead of a gas, which he said had been used before. Coming to the description he said, "I have discovered that even a cotton thread, properly carbonised and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere offers from 100 to 500 ohms resistance to the passage of an electric current," &c. He did not there use the word filament. All he said was that he had discovered that even a carbon thread properly carbonised, and so on, would offer a certain amount of resistance, and then he went on to point out the advantages of that burner or thread being coiled as a spiral; it enabled you to get a longer length into your bulb, and thereby a greater resistance, and it also enabled you to present a greater radiating surface. That was the sole description Edison gave of the mode of manufacturing his filament. In the part of the patent where he described his tar and lampblack wire, made of thick putty stuff, which was to be wound into a spiral, he called the article which he produced a flexible carbon filament; but that was the only place in which those words occurred. The patentee did not confine himself to any diameter or claim any diameter; each wire, however, was to be uniform in size throughout. Coming to the claiming clauses, Sir Horace Davey said the first claim was for an electric lamp giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires, as set forth. This claim was for the burner used in an incandescent electric lamp, and not for the whole lamp. The claim for the whole lamp was the second one. Their lordships would observe that the words "made as described" were omitted in the second claim, which was for a combination of a carbon filament within a receiver made entirely of glass through which the leading wires passed, and from which receiver the air was exhausted for the purposes set forth. The learned judge had construed these words, at the invitation of his learned friends, as meaning every carbon filament. He held—he (Sir Horace) did not say his learned friends were bound by that before their lordships—that no infringement by the defendants had been proved of a lamp containing a carbon filament made as described, but he construed that claim as meaning any carbon filament, however made. Construing the claim in that way, he could not deny that the defendants' lamp was an infringement—was something which might be called a filament; but that it was made as described by Edison there was not a scrap of evidence to show, and it was not the fact. The first point for their lordships would be to say whether the construction which his learned friends invited the learned judge to put upon the second claim was the right one, whether he was right in saying that it included every carbon filament, however made, and that it was not confined to carbon filaments made in the particular mode, or in any one of the modes, described by Edison in the previous part of his patent. If their lordships put the narrower construction upon the second claim, then it would be his duty to submit, as the learned judge had held, that there was no evidence of infringement. But if their lordships adopted the larger construction and held that everything which was a combination of a glass bulb or receiver exhausted into a vacuum with a filament and leading wires passing through the glass, then their lordships would, he was afraid, have to answer the question, what is a filament? There was one remarkable thing upon the face of this patent. If Mr. Edison did make this wonderful invention it was extremely remarkable that he had not given some further description of it. All that he said in regard to the use of the filament, apart from the spiral, was that he had discovered that cotton thread when carbonised would offer a resistance of from 100 to 500 ohms. If any inference was to be drawn from that passage, it was that Edison meant by a filament a cotton thread which when carbonised would give a resistance of from 100 to 500 ohms; and accordingly the learned judge did say that in his opinion a lamp of less resistance than 100 ohms would not come into the patent. His learned friends, for excellent reasons, resisted anything of that kind being put into the order. The learned judge's inference was logical. The only place where the patentee spoke of a filament was on page 4, between lines 38 and 43: "I have carbonised and used cotton and linen thread, wood splints," &c. Now, it was certainly remarkable, if, as they were now told, the great merit of the invention was the discovery that by reducing the size of your carbon pencil you would obtain particular advantages, that he had not given a more detailed description of how that was done. If the merit of the patent was that he had discovered particular modes of how the burner was to be made, by carbonising bits of wood, threads of wool, of hemp, or any fibrous vegetable substance, that might or might not be a patent of great merit, but in that case Edison might go on his way rejoicing for anything he (Sir Horace) cared, because that was not what the defendants did. But if he supposed that the pith and marrow of his invention was the discovery that the reduction of the size or sectional area of the burner in the incandescent lamp would give particular advantages, then he said that was not what was described in the patent, and he also said that that was too indefinite, too vague, and not proper subject matter of a patent. That was like telling a person he might gain a particular advantage by reducing the size or the proportions of a particular part of a well-known machine, assuming, as there could be no question, that a lamp in all respects resembling Edison's, except that the burner was one-twentieth of an inch in diameter, had before been described and exhibited. According to their (defendants) theory, and they were supported by well-known authorities, that was not a proper subject matter of a patent. They said, in fact, that this question of the filament was a mere question of degree, and, although it might be a meritorious discovery, it was not a discovery which constituted subject matter of a patent. They further said that the second claim as construed by his learned friends, was far too vague to be a good claim, because a patentee was bound to have a definite boundary wall. He claimed a monopoly, and he had a monopoly granted to him by the law; he undertook the obligation, and was bound to tell the public how far they might go, and where his domains began. No doubt trespassers were liable to be prosecuted according to law; but the patentee was bound to put up his fence and tell people where his domains began and beyond which they might not go. (The Court here adjourned.)

On Tuesday, Sir HORACE DAVEY, resuming his argument for the appellants, read largely from the evidence taken at the trial, commenting upon such portions as supported the view he wished to place before their lordships. Upon the question of the word filament, after reading the definitions of several dictionaries, counsel said the only definition which had yet been arrived at was that it meant something more or less long, and more or less thin; but into no one of the definitions did flexibility or resiliency enter, although it might be true that if you reduced the sectional area of your thread or pencil you did get greater flexibility, but the flexibility varied within almost infinite degrees, according to the material of which you formed your filament. The flexibility of a splint of wood would be extremely different from that of a thread, for example, so that, although flexibility might be the result of a filament, it was not included in or connoted by the word filament. Having read the specifications of King, Roberts, Van Choate, Pulvermacher, Lane Fox, &c. (with all of which our readers are probably familiar), in order to make their lordships acquainted with the state of knowledge at the time Edison filed his specification, Sir Horace Davey contended that, giving Edison's patent the fullest latitude, it amounted to nothing more than a statement that the patentee had discovered that a reduction in the size of the burner would give particular beneficial results, and quoted the cases of Kaye *v.* Marshall, Ralston *v.* Smith, and Pattison *v.* The Gas Light and Coke Company. Applying the judgments in those cases to the patent before their lordships, how could they say whether the patent had or had not been infringed when the subject of that patent was a mere matter of degree and not of positive definition and description? A man had no right to take out a patent for a particular mode of using or for a particular form of a well-known machine. Having regard to the evidence, and having regard to their own knowledge of the English language, was it possible for their lordships to interpret this patent as it had been interpreted in the Court below and to limit with precision what had been invented or patented? He then called their lordship's attention to a part of the evidence which, he said, went to the very root of the matter. Supposing that his learned friends were right in saying that the great merit of Mr. Edison's invention was that his filament was shaped before it was carbonised, they had the most conclusive evidence to show that even that was not new at the date of Edison's patent, and that a French gentleman named Sidot had written a paper which was published in *Comptes Rendus*, in which he described a mode of carbonising filaments of thread and splints of wood, and stated that those threads and splints of wood when carbonised would be useful for the purpose of the electric light.

On Wednesday, Sir HORACE DAVEY concluded his argument by reading the judgment of Mr. Justice Butt, and commenting upon the points therein to which he objected.

Mr. ASTON commenced the opening of the argument for the plaintiffs, saying that if one thing had been made more clear to their lordships' minds than any other, both by the reading of the learned judge's judgment and the address of Sir Horace Davey, it was that prior to the date of Edison's patent there was no good, practical working incandescent lamp. Various attempts had been made by a number of inventors before Edison, but all fell short of the solution of the problem. People knew perfectly well that carbon was a good material to use if they could get it in the right shape; Lane-Fox was upon the threshold of the real discovery when he employed metallic wire; but nobody hit upon the right method, which was to use carbon wire.

Mr. ASTON, on Thursday, begun by reading the published account of Mr. Swan's lecture at Newcastle, and said upon that he founded the observation that Mr. Swan, who had come the nearest of all persons to Edison's discovery, had failed to see that one great cause of the irregular action of his lamp, and of its want of practical utility, was that he used a carbon rod instead of a carbon filament. It never occurred to him to say, "I get disruption because I have my carbon in the wrong physical shape and form." He was going upon the deposit; he was going upon what caused the glass of the lamp to become so obscured that after a time the rays could not permeate through it. He did not hit upon the fact that a new departure was necessary. It was important to consider the state of mind in which Mr. Swan was at the time he delivered that lecture. First of all he admitted that it was an experiment; secondly, that as an experiment it was a failure; and, thirdly, he said he hoped very shortly to cure the defect. But how? Not by a new departure, but by practising on his old carbon rods, and if he had continued to use those carbon rods his failures would have been repeated.

LORD JUSTICE BOWEN: You say that the important difference was in the first place dimension of sectional area, and then you say an addition of flexibility which had not been found before. Of course, filaments may be made of various materials of various kinds of natural flexibility. Is the addition of flexibility upon which you rely anything else than that which depends upon the dimension of sectional area?

Mr. ASTON: I do not know that it does, my lord—and increased length. You must have a long surface, and so have a sufficient amount of radiating surface, but at the same time you must have a sectional area such as will give you the requisite flexibility and resiliency.

LORD JUSTICE BOWEN: I do not see that any indication of that is to be found in the specification.

Mr. ASTON thought that all through there was a consistent reference to the important step Edison had made in the progress of invention by substituting for his metallic wire one possessing the qualities he (Mr. Aston) had stated.

The LORDS JUSTICES at several stages of Mr. Aston's remarks asked if a lamp had been put in which was made in accordance with the patent which was the subject of the action, without any subsequent improvements; and whether there was any evidence of lamps so made having been in commercial use. Mr. Aston was unable to definitely answer the questions, but stated that the Attorney-General, who was to follow him, said there was evidence as to a lamp made under Edison's patent. Alluding to a point raised by Sir Horace Davey, Mr. Aston said that both the dynamo machine and Sprengel's pump, to which inventions Sir Horace attributed the success of the incandescent lamp, were well-known long before the date of the patent. Speaking of the Sidot paper, he submitted that if Mr. Edison had put into his specification, "I make my filament in the way I have described, or in the way described by Sidot," it would not affect the second claim one bit. Replying to Lord Justice Cotton, Mr. Aston said he did not think the flexibility and resiliency of the carbon filament after it had become a carbon filament, was pointed out in terms in the specification, but he contended that upon the evidence anybody who made a filament in the way described would produce a filament which of necessity possessed those characteristics.

The ATTORNEY-GENERAL (Sir Richard Webster) said Sir Horace Davey's argument was only possible if he disregarded the evidence given before the learned judge. It was conceded by the defendants' witnesses that the combination described in the patent was new; and he submitted that that being the case, there could be no question of its validity. (The learned counsel had not concluded when the Court rose for the day.)

NOTES.

Electric Lighting in America.—The electric lighting industry appears to be in a most flourishing condition in the States, no less than 14 companies having been newly incorporated. These are, however, small concerns compared to what we are used to in England, the capital of the majority varying from $20,000 to $100,000, although one, the Edwards Electric Light Company, starting the manufacture of head lights for locomotives, has a capital stock of $2,000,000.

Pearl Fishing by Electric Light.—The steam yacht *Chic*, belonging to Messrs. Alley and McLellan, engineers, Glasgow, which has been berthed in the Greenock harbour for the past few weeks, has been fitted up with a Brush dynamo for the purpose of suiting her for the pearl fishing in South Australian waters. The *Chic* left on Saturday for the Gareloch, where she will remain until the arrangements are complete for fitting up the electric lamp.

Street Lighting.—On Tuesday a deputation attended before the Commissioners of Sewers with a memorial from ratepayers of the Ward of Cheap, calling attention to the defective lighting of Cheapside. The petition was signed by 34 inhabitants. Mr. Deputy Bedford: Would you like to return to the electric light in Cheapside? Mr. Stoneham: Yes, very much. Mr. Bridgman was surprised to find how speedily the electric light was got rid of. The lighting in Cheapside was disgraceful. Mr. Deputy Walter said not only Cheapside, but Fleet Street ought to be better lighted. The subject was referred to the Streets Committee.

Proposed Electric Lighting at Plymouth.—A series of experiments with the electric light have been arranged to take place at Plymouth during the first week of the new year, and a committee has been appointed to make the necessary arrangements. Messrs. Laing, Wharton, and Down have consented to supply 16 Thomson-Houston arc lamps, each of 600 candle-power, for use on the occasion. Several places of business are to be lit in the most busy thoroughfares of the town, and the wires are to be so arranged that they can be utilised inside or out, as may be most expedient. The steam engine is to be supplied by the committee, and the dynamos and other apparatus by Messrs. Wharton, Laing and Down.

Electric Light in Londonderry.—Mr. A. W. Richardson, of the Anglo-American Electric Light and Engineering Works, Stretford Road, Manchester, has just completed an installation of 80 20-C.P. incandescent lamps in the laundry department of Messrs. Welsh Margetson's shirt factory, Londonderry. The dynamo for working same is an H type compound shunt self-regulating "Richardson" machine, which gave at the trial 110 volts and 55 ampères at a speed of 440 revs. per minute.

Temporary Lighting.—At a dance given at Mr. J. Bergthiel's house, 38, Warwick Road, W., recently, the rooms were illuminated by 21 Woodhouse and Rawson incandescence lamps, the current being derived from accumulators placed in the garden close by. The use of accumulators and lamps for temporary lighting purposes is vastly on the increase, and is one of the means of promoting the popularity of the electric light which should not be lost sight of. The installing was effected by Mr. Arthur Bergthiel, of Messrs. Woodhouse and Rawson.

Lighthouse Illumination.—Owing to the increased cost of maintaining the Isle of May Lighthouse, caused by the introduction of the electric light, an Order in Council has been issued authorising the collectors of light dues to levy $\frac{1}{8}$th of a penny per ton on vessels carrying cargo or passengers which may pass or derive benefit from said light when on a coasting or home trade voyage; and one penny per ton on vessels when on an over-sea voyage, subject, however, to the usual deductions. During Wednesday night last week the engineers to the Commissioners of Northern Lighthouses were out in the Firth of Forth on board the steamer *Pharos* for the purpose of testing the powee and efficiency of the new light on the May. The increased rates above referred to came into force on the 1st inst.

Electric Lighting by Day.—The somewhat novel experiment of shutting the dull light of a December day entirely out and substituting electric illumination, has been carried out with much success at a bazaar held in St. George's Hall, Bradford. The electric light was used with a view of doing away with the gaunt and desolate aspect which the hall presents during the day. The contract for the lighting was given to the local Woodhouse and Rawson Company, and the work was carried out under considerable difficulty. A semi-portable 12 H.P. engine was used to produce the power. The main lights were four arc lamps of 2,000 candle-power, three being suspended inside the hall and one out. About seventy 20 candle-light incandescent lamps were also hung round the room at intervals, and a Christmas tree, which stood in the hall, had its toys and bon-bons illuminated by half-power incandescent jets, which were placed in small coloured tubes.

The Telephone and the Stage.—The Edison Gower-Bell Telephone Company of Europe has recently carried out, under the supervision of Mr. Alan Danvers, an arrangement by which the opera in Lisbon has been transmitted telephonically to the company's subscribers. Great satisfaction has been expressed with the experiment, and a more extended list of subscribers is anticipated for the enterprise next season.

Proposed Telephone Exchange for Gloucester.—The desirability of establishing a telephone exchange at Gloucester formed the topic for discussion, a few days since, at a public meeting presided over by the mayor. Mr. C. Nash, chairman of the Western Counties and South Wales Telephone Company, delivered an address, in the course of which he explained the working of the Bristol Exchange, which had now become almost a necessity—and emphasised the advantages which the system would bestow on Gloucester by connecting the town with Bristol and Sharpness. Mr. Dixon, traffic manager of the canal, incidentally mentioned that he had arranged for a private wire between Gloucester and Sharpness, which would be in working order early next year. Mr. Lewis, secretary to the telephone company, announced that 20 subscribers would be required before an exchange could be opened in the town. The subscription would be £12 per annum. The meeting was then adjourned.

The Use of the Telephone.—The calls through the London Exchange system of the United Telephone Company on the 7th inst. amounted to 38,173, the highest yet reached for any one day; while the calls for the week, ending also on the 7th inst., amounted to 210,848, which, allowing for one answer to each call, represents 421,696 messages for the week.—*City Press.*

The Telephone at Southampton.—The Western Counties and South Wales Telephone Company is making gigantic strides in Southampton. Southampton, according to its *Observer*, has generally been slow to recognise the value of inventions or the introduction of schemes likely to lead to the extension of trade and commerce. Hence its backward state; but the benefits of the telephone, when based upon a proper system, and in skilful hands, have been so apparent that opposition has been silent, and even those who at the onset had doubts of its utility, have been convinced of its thorough usefulness. Twelve months ago there were only four private wires in the town; now there are 41 and one in course of construction. In addition to this the company now has 47 subscribers to its exchange. The derrick over the company's offices 86, East Street, was fitted up five and a half months ago for 50 wires, as an experiment. Now, the company has found it necessary to make provision for double the original number. as the orders increase so rapidly. The success of the company in Southampton is due, according to the authority we have already quoted, as much to the energy and business capacity of Mr. H. F. Lewis, the general manager and secretary, and Mr. Fitzsimons, the local superintendent, as to the merits of the system itself.

The Telegraph in Greece.—The department of posts and telegraphs has been lately entirely reorganised, the administration being now composed of one director general and three sub-directors, one of whom takes charge of the telegraph business, the other two being at the head of the postal department. The number of telegraph offices open to the public in 1885 was 149, but the most notable addition to the telegraph system consists in the numerous cables recently laid between the islands and the mainland, with the effect that the communication which hitherto had been in the hands of the Eastern Telegraph Company now form a part of the telegraph department. The only telegraph business which the aforesaid company has now the command of is the International service. The length of the land lines was 2,565 kilometres in 1875, and 4,667 kilogrammes in 1882. The land lines have not been increased, the length in 1885 being 4,667 kilometres, but the submarine cables in the last-mentioned year showed the very respectable total of 3,775 kilometres.

Electromotive Force. — A correspondent to the *English Mechanic* quotes a passage from the ELECTRICAL REVIEW as follows:—"When the external resistance approaches the internal resistance, the E.M.F. of the cells will be reduced, and if the external was made equal to the internal resistance, the E.M.F. would be but half that indicated when the external resistance was high. How is this? I thought that the E.M.F. of any cell depended solely on the materials composing the two plates, and the composition of the battery acid as representating electro-chemical actions of various kinds, each of which produced its own particular E.M.F." The above statement is correct. "Torbay" confuses the full potential or E.M.F. on open circuit with the free potential when the battery is working. If he will measure the E.M.F. of a cell which is not connected up with any exterior circuit, he gets the full potential between its terminals, but if he joins the terminals up to a resistance equal to the internal resistance of the cell, he will find that only half the potential is free. If he proceeds still further and short circuits the cell with a thick piece of copper wire, he will find the free potential between the terminals reduced to practically zero.

The "Franklin Institute Journal."—The December number of this journal is very interesting. Amongst the articles which are directly associated with electrical matters we notice one, originally delivered as a lecture by Prof. M. B. Snyder, on "The Electrical Exhibition and pure research"; and another on "The practical deductions from the Franklin Institute tests of Dynamos," which has already appeared in the REVIEW. The remarkable paper on "Turbines," by J. Lester Woodbridge, M.E., is here concluded from the November issue.

The Physical Society.—At the last meeting of this Society, held on the 11th inst., Mr. Shelford Bidwell exhibited and described a voltaic cell, in which the electrolyte is dry peroxide of lead. It consists of carefully dried peroxide, placed between plates of lead and sodium, and gives a comparatively strong current, which passes from the sodium to the lead within the cell.

Prize Competition. — The Industrial Society of Amiens has published the subjects for prize competition for 1887. The manuscripts or models must be in the hands of the president before the 30th of next April. The prizes are the following : A gold medal for a brake dynamometer to be used instead of the Prony brake, but to be more handy and more easily applied. A gold medal for a transmission dynamometer of simple and cheap construction, by which the power supplied to any tool or machine, either by belting or gearing, can be easily ascertained.

Electric Locomotion for Railways in France.—It is proposed for some local lines in France to partially employ electric locomotion. These lines, which are of one metre gauge, generally have a few heavily laden trains, but all the other trains although having only a few passengers, say 20 to 30, have to be hauled by the same comparatively heavy (24 tons on these lines) and expensive locomotive, and this does not give any profit to the company. It is proposed to replace these costly trains by some carriages fitted with accumulators and motors. For one of these lines, near Paris, two waterfalls situated at the extremities of the line, and of 8 H.P. each, would be used for continually charging the accumulators. In case of failure of the water-power in dry summer or in winter, the motive power would be taken from the repairing workshops which have an excess. The Reckenzaun system is intended to be used on this line. We are not able at the moment to give more information on this subject, but we might say that perhaps in England our railway engineers will find this application of electricity useful for local trains on sections with small traffic, and also in the case of special trains, electric carriages and light specially built carriages for 10 passengers only, would be of use to the travelling public and give profit to the railway company.

Clark's Transit Tables.—We have received a copy of the new edition of Clark's Transit Tables for 1887, which have just been issued by Messrs. Spon, the publishers.

Personal.—Mr. Bernard Drake, of the firm of Messrs. Drake and Gorham, has been appointed to act as electrical engineer to the Bank of England.

The Glasgow Chamber of Commerce.—At a meeting of the directors of the Glasgow Chamber of Commerce, held on Monday, Mr. Anderson Smith read a paper on the development of the fisheries of the West Coast of Scotland. He advocated further the adoption of larger fishing boats, the erection of harbours, and an increase of means of telegraphic and other communication with the principal markets. Fifteen miles of cable would connect all the small islands, and a little more would unite Coll and Tiree with Oban, and when that was accomplished the westward fisheries would prosper and be successful. He asked the support of the members of the Chamber to urge upon the members of the Government to remove the isolation of the Western Islands, to extend mail communication, and if possible to connect every lighthouse with the telegraphic centre.

Paris and Brussels Telephone Intercommunication.—The system of telephone intercommunication which is being established between Paris and Brussels is not, says *La Chronique*, to be on the Van Rysselberghe plan, but by means of a special double wire of bronze. The total distance between the two capitals is 310 kilometres, and the wire to be used will weigh 63½ kilogrammes per kilometre. The cost will be 155 francs per kilometre, exclusive of the cost of erection. The double wire is to be placed on existing poles. The charge for 5 minutes intercommunication is to be 3 francs. The terminal stations are to be in the *Bourses* of the respective capitals, and at present no arrangements will be made as to putting the wires into connection with local exchanges.

Electric Clocks for South America.—An export house in Stuttgart, *Industries* states, has just supplied to the town of Caracas, in Venezuela, a number of clocks for the public streets. On account of frequent earthquakes, clock towers are not advisable, and since the clocks must be placed low, a comparatively large number is required. Amongst the clocks sent out is one with a dial 13 feet in diameter. All the clocks will be worked electrically, and illuminated at night with the electric light.

Printing by Electricity.—The *American Inventor*, of Cincinnati, a large monthly journal, says :—"We print this month's issue for the first time by means of electricity. The Sprague motor is used, and is an immense advance on any other kind of power. We are running four presses with a single motor, and it is quite a novelty in action. The motor is built in a very substantial manner, and there are no parts that wear rapidly even with ordinary care. The expense for repairs cannot amount to 10 per cent. of that required for either steam, gas, or hot-air engines, and we now see no reason why it will not give, for many years to come, as good results as at present."

New Price List.—We have received from Messrs. Drake and Gorham, a price list of their accumulator. This is the latest development of a well-known pattern as regards plates and dimensions, but with improvements in the grids, and a better method of insulating the plates. The list will be found useful as giving data to electrical contractors who have not always the time or inclination to work out the cost of each battery for themselves.

Electric Lighting from the Grosvenor Gallery.—St. James's Hall, Piccadilly, is, we are informed, to be lighted electrically from the Grosvenor Gallery, and that if successful it is almost certain that the Princes' Hall, also in Piccadilly, will follow.

Electricity in the Royal Navy.—According to alterations about to be made in the Queen's Regulations, the electric light apparatus, so far as regards the lamps, projectors, and conducting wires, on board Her Majesty's ships, will in future be, for store purposes, in charge of the gunner or the officer in charge of gunners' stores, except in troopships and other vessels which bear neither torpedo ratings nor a gunner. In these ships, the engineer officer is to have charge of the whole of the electric light apparatus and stores. The dynamos and engines for driving them are to be in charge of the engineer officer, who is responsible for their mechanical and electrical efficiency. The torpedo officer is to be responsible for the efficiency of all electrical circuits, outside dynamo terminals, and for the management of the internal search, yard arm, and other electric lights. In ships where there are torpedo ratings, but no torpedo officer, the captain is to nominate the fittest person to perform the above-named duties from officers who have gone through a lieutenant's short course or a sub-lieutenant's course in the torpedo school. The search lights should be frequently exercised to instruct the officers and men as to their capabilities for defence against torpedo boats, directing the fire of guns and signalling purposes, under the direction of the torpedo officer or the officer nominated, and the particulars of such exercises are to be inserted in the half-yearly report of torpedo practice.

What Was It ?—A friend informs us that on Monday evening last a curious display of what was at first taken for fireworks, might have been seen over New Bond Street at the point where the Grosvenor Gallery mains cross the road. Our friend suggests that the wires had become short circuited.

Electro-Motors and their Government.—We are compelled to leave over a paper on this subject, which came to hand too late for insertion in our present issue. We may add that Mr. W. M. Mordey is the writer.

Electricity for Therapeutical Purposes.—A correspondent writes :—"Captain Arthur Byng, R.N., who has devoted some years to the study of electricity in reference to its qualities for alleviating and curing various nervous diseases, has recently opened rooms at Portsmouth, fitted with apparatus which will enable any number of persons to be treated at the same time. Captain Byng claims no new method of generating electricity, and his patent applies merely to a system of sub-dividing the current so as to disseminate it equally throughout a room and administer it in various strengths to the persons sitting in that room. The positive and negative poles of a large coil are placed in connection with an insulated floor and ceiling, the former being constructed with sheet metal, and the latter with wires broken by steel points, so that anybody standing on the floor is actually between the poles and becomes charged with the electric fluid. A number of regulators are distributed over various parts of the room, so that the patients themselves can regulate the force of the current, and if necessary diminish it to a minimum." We anticipate a rush on this establishment. What a high old time the patients can have amongst themselves by the playful manipulation of the regulators.

Lecture on Electroplating.—We are requested to state that at Professor S. P. Thompson's lecture at Finsbury Technical College, on Thursday, December 23rd, on "Dynamo Machines for Electroplating," free admission will be given to any person engaged in the electroplating industry, who will apply beforehand for a ticket of admission.

The Weather and the Telegraphs.—A very heavy and severe snowstorm passed over the Midlands on Tuesday, the temperature of the atmosphere being in just that condition which admits of the snow clinging to the wires. In the Peak district the fall was very heavy, roads being blocked in several instances. The telegraph wires became loaded with snow, and in many cases might be observed borne down by its weight almost to the ground. Happily, the fall was not accompanied by any high wind. Such, however, has been the pressure brought to bear upon the poles, that in one instance it was sufficient to break a stay composed of 5 No. 8 Homo-G. I. wires—each one of which was under specification capable of withstanding a strain of 1,800 pounds. It is probable that considerable damage has been done to the telegraphs, as the storm extended over a considerable area.

Transmission of Power. — The following table, giving a comparison between the experiments carried out by Marcel Deprez and Hippolyte Fontaine, may be of interest. Our readers will remember that Marcel Deprez worked with one generating and one receiving machine, both of heavy type, while Fontaine used four small Grammes joined up in series as generators, and three small Grammes, also joined in series, as receiving machines :—

	H. Fontaine.	M. Deprez.
Number of generating machines	4	1
Number of receiving machines	3	1
Total weight of machines	8,400 kg.	5,000 kg.
Total cost of machines	16,450 fr.	80,000 fr.
Resistance of line	100 ohms.	97·45 ohms.
Potential at terminals of first machine	1,490 volts.	6,004 volts.
Potential at terminals of second machine.	1,505 volts.	—
Potential at terminals of third machine	1,493 volls.	—
Potential at terminals of fourth machine.	1,508 volts.	—
Current	9·34 ampères.	9·789 ampères.
Speed of generating machines	1,298 revs. p. min.	200 revs. p. min.
Velocity of periphery	22·5 metres p. sec.	7·5 metres p. sec.
Industrial efficiency returned	52 per cent.	44·8 per cent.

Gas and Electrical Engineers. — In the *Revue Industrielle* for the 16th inst., the following advertisement appears :—A large firm of manufacturers, dealing specially with installations of lighting by gas and electricity, requires engineers perfectly familiar with engines and electrical apparatus, as well as their erection, and willing to travel when necessary. Address, *Revue Industrielle* Office, 48, Rue de Bondy, Paris, giving references.

Calculations Extraordinary.—The calculations by Dr. Fleming, which may be found in the Society of Arts discussion, remind one of the man who, having heard that ravens lived for 200 years, bought one to try.

The British Association.—The final meeting of the local executive committee was held at Birmingham on Wednesday, the Mayor (Alderman Martineau) in the chair. Reports were received from the exhibition subcommittee and from the local officers, from which it appeared that the exhibition yielded a surplus of £5,200. After defraying out of this sum all expenses connected with the meeting of the association in Birmingham, there remained an available surplus of £1,311 1s. 5d. It was resolved that this sum be devoted to the provision of a permanent record of the meeting of the association in Birmingham, and of the exhibition to which it gave rise, by the purchase of a collection of illustrations of art in the Birmingham metal work exhibition at Bingley Hall, to be placed in the museum and art gallery, and that a select committee be appointed to make the necessary purchases.

Ocean Bottoms.—In the December number of the Proceedings of the Royal Geographical Society, just issued to the Fellows, is a most interesting paper on "Similarities in the Physical Geography of the Great Oceans." This paper was read before the Royal Geographical Society at the evening meeting of the 8th November last, and treats on some of the results of the observations made on board H.M.S. *Challenger* during her voyage round the world, Mr. Buchanan having accompanied this expedition as chemist on the scientific staff. Mr. Buchanan also gives the results of the observations made by himself and the staff of the Silvertown Company, so far as they relate to the subject matter of his paper, during the voyage of the cable steamer *Buccaneer* on the West African Coast while making the preliminary survey for the laying of the West African Company's cables. To readers connected with submarine telegraphy, and who naturally take a lively interest in such matters, we commend a study of Mr. Buchanan's paper, which breaks a considerable amount of new ground in the science of oceanography.

Erratum.—In the article on Clark's Standard Cell, published last week in the second column, page 561, second and third lines from the top, instead of "for the temperature coefficient," read "for the electromotive force" =

$$0{\cdot}98988 \left\{ 1 - {\cdot}00074377\,(t-15) - {\cdot}000004147\,(t-15)^2 \right\}.$$

Welding by Electricity.—The New York correspondent of the *Standard*, telegraphing on Monday night, says :—"Prof. Thomson has demonstrated before the Society of Arts a novel application of electricity. By placing pieces of metal end to end under a forcible pressure, and passing an electrical current through them, perfect weldings are effected, even between metals otherwise incapable of being welded together, or between different metals. To weld steel of one-and-a-half inch diameter, a current of 6,000 ampères, having an electromotive force of half volt, was necessary. It is stated that the use of 35 horse-power for one minute will weld that thickness of steel without any blows or the application of other heat. Steel also may be welded in this way to brass." This system of welding was described and illustrated in the REVIEW a few weeks ago.

Storage Batteries in America.—The success of the Julien Electric Car in New York, has apparently led to the insertion of the following paragraphs in the daily press :—

On May 17, 1882, the public was cautioned against making investments in any scheme or venture based upon the claims of one Camille Alphonse Faure, relating to secondary or storage batteries or accumulators, and notice was then given that the Brush Electric Co., of Cleveland, were the rightful owners in this country of the inventions laid claim to by Faure and others and were enforcing their rights by proceedings before the proper tribunals of this government. Those proceedings have been pushed with diligence by the Brush people, and have been opposed and delayed in every possible way by the Faure interests and others for a period of four years. Decisions, however, have at last been rendered in favour of the Brush interest and patents have been granted to it covering the entire ground claimed by the Faure people, and the Faure patent is thus rendered valueless. Twenty-seven patents, covering the field above referred to and of cognate scope, have been granted to the Brush Electric Co., and one or more of them cover all the commercial batteries that have been up to now devised. The two principal and foundation patents, which control the use of the so-called Faure storage battery, as well as the Sellon-Volckmar battery and others in this country, and supersede the patent issued to Faure, Jan. 3, 1882, numbered 252,002, are dated and numbered respectively March 2, 1886, No. 337,298, and March 2, 1886, No. 337,299.

The public are again advised, as they were in 1882, of the rights of the Brush Electric Co., and that these rights will be enforced.

Particulars may be learned of the undersigned, or of William C. Witter, Esq., or William H. Kenyon, Esq., their counsel, 32, Park Place, New York.

BRUSH ELECTRIC CO., Cleveland, O.

Electric Locomotion in America.—It appears that the Philadelphia Traction Company, which operates the majority of the street tramways of that city, are about to experiment with cars carrying electro-motors and accumulators. The first experiment will be on the Chestnut Street line, and if commercially successful, doubtless the electrical system will be generally adopted.

Electro-Pneumatic Transmission.—Sometime since we called attention to the scheme of Mr. Henry Clay, for transmitting messages and parcels through pneumatic tubes, controlled by electricity. It seems probable that the system will shortly be in operation in Philadelphia, permission having been given to the Electric-Pneumatic Company to lay tubes in certain streets of the city. As our readers have already been informed, the system differs from that of the ordinary pneumatic tube system practically in only one particular. Instead of a single tube stretching from a given point to a certain destination, a main tube is laid along certain streets from which any number of connecting tubes branch off. By an ingenious method of switches, operated by electricity from the main office, a conical carrier containing a message or parcel traversing the main tube will find its way suddenly blocked and will be turned into a side tube by means of a switch, much as a street car is turned from one street into another by means of an intercepting bar.

"Nothing New Under the Sun."—Under the title of "Some Little-known Historic Inventions," M. Abdank Abakanowicz last month brought before the Société Internationale des Electriciens a paper in which he showed that many of the inventions said, and generally thought at the present day to be, new, are actually of ancient date. The inventions to which he referred ought, he considered, to take their proper place in the history of electricity. The conclusions which M. Abakanowicz brings out are as follows :— The electric motor of M. Deprez is the same as the motor of A. N. Allen, patented on the 2nd of February, 1872. The electric hammer of M. Deprez was realised by Page in 1850. The principle of double-winding brought out by M. Deprez, was discovered by Maxim in 1882. The method of demagnetising watches announced by M. Deprez, was devised by Maxim and published by him in 1881. The employment of two rings induced in the same dynamo, which is attributed to M. Deprez, was indicated by a correspondent to the *Electrician* (London), in April, 1882. Finally, the so-called characteristic curves of dynamos of M. Deprez were first alluded to by Dr. Hopkinson in a paper read before the Institution of Mechanical Engineers in April, 1879. M. Abakanowicz has promised to continue his researches and to publish the results.

Sewage Pumping by Electricity.—So much has been said and so little practical work done in the transmission of power by electricity, that it is a pleasure to chronicle a thoroughly successful installation. Such a one has been recently brought to our notice at Hatfield Park, Lord Salisbury's seat. Lord Salisbury's interest in all that pertains to electricity is well known, and we have already had occasion to notice what has been done at his house and park in electric lighting. Mr. Shillito, who has carried out all the work, has now made a new departure by using electricity for the purpose of pumping the sewage from Hatfield House to the irrigation farm on the estate. The River Lea runs about $1\frac{1}{2}$ miles from the house, furnishing a large supply of water at a good head. A turbine has been put up at one of the mill races, by which two small dynamos are driven, and the current so produced is carried by iron wire cables, slung over head, to the motor, placed about 500 yards distant close to the tanks into which the sewage flows from the house by pipes. This motor drives a series of pumps which force the sewage nearly half a mile, with a rise of about 40 feet, to a large tank placed on high ground, from which the adjacent fields are irrigated in the usual way. There is a loss in the conversion of power from the river to the pumps, through turbine, dynamos, cables and motor, but this is more than compensated by the advantages. There is no supervision required, the machinery running day and night absolutely by itself, and though in use for some months it has given no trouble, and an occasional visit from one of the men to see that it is at work is all the care it has had. Mr. Shillito has put the installation up with a view to its being run by farm hands without skilled labour, and in this he has been most successful. It is all solid, practical work, and we have much pleasure in congratulating Mr. Shillito in his success.

Queensland Telegraphs.—We have received the report of the Postmaster-General of Queensland on the Post and Telegraph Department for the year 1885. It includes the report of the Superintendent of Electric Telegraphs, Mr. A. Matveieff. From this we learn that since the last report 440 miles of new line have been erected, involving the use of 1,047 miles of wire. There are now 7,537 miles of line and 12,608 miles of wire open for public business.

NEW COMPANIES REGISTERED.

Electric Tramways Construction and Maintenance Company, Limited.—Capital £250,000 in £1 shares. Object : To acquire the letters patent granted to Michael Holroyd Smith, of Halifax, consulting and mechanical engineer, for improvements in tramways and railways, and for the use of electricity as a motive power for tramcars. Signatories (with one share each) :—M. Holroyd Smith, Warley, near Halifax ; A. F. Jennings, 3, Cheverton Road, Hornsey Lane ; F. R. Wright, 115, Gresham House, E.C. ; F. G. Summers, 21, Landcroft Road, East Dulwich ; W. H. Handley, 5, Cambridge Terrace, West Green, N. ; A. Kingsbury, Earlsfield Road, S.W. ; F. H. W. Power, 56, Great Russell Street, W.C. The first directors are—A. J. Lambert, A. S. Bolton, G. F. Fry, Colonel Francis Cornwallis Maude, V.C., C.B., Thos. Shaw, M.P., and William Ward; qualification, £250 in shares or stock; remuneration, £500 per annum, with an additional £200 for each 1 per cent. of dividend above 10 per cent. per annum. Registered 8th inst. by Wilkins, Blyth & Co., 112, Gresham House.

Harrison's Synchronous Clocks Company, Limited.—Capital £2,000 in £1 shares. Objects: To purchase from Wm. Samuel Harrison, of 23, Falkland Road, Kentish Town, electrician and clockmaker, the letters patent, No. 3,578, dated 20th July, 1883, granted for an improved synchronising and time signalling mechanism for clocks. Signatories: Benjamin Green Pinner, 100 shares; Henry Ryan, 34, Seething Lane, 50 shares; E. C. Dawson, 306, Kentish Town Road, 10 shares; E. Almond, 285, Kentish Town Road, 10 shares; C. J. Simmons (electrician), 56, Leverton Street, N.W., 5 shares; S. Radford, 2, Bushy Place, N.W., 30 shares; S. H. Roberson, 17, Abchurch Lane, 1 share. Registered 11th inst., without special articles of association, by Claudius George Algar, 17, Abchurch Lane.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Automatic Electric Railway Signal Company, Limited.—An agreement dated 1st inst. provides for the purchase by this company from Mr. Walter Walker, of 6, Elsworthy Road, N.W., of the British letters patent No. 11,645, dated 30th September, 1885, taken out in the name of H. J. Gardner, and described as an "Improved method of railway signalling by automatic electric lanterns or semaphores," and also an invention by Mr. Walker, described as an "Improved method of automatic electric signalling for railways and apparatus therefor," for which a complete specification for British patent, dated 2nd ult., No. 14,105, has been filed. The purchase consideration for the first mentioned invention is 5,000 fully paid shares of £1 each, and for the second 45,000 fully paid shares.

Incandescent Electric Lighting Company, Limited.—The official returns of this company for 1884, 1885 and 1886 were filed on the 11th inst. The last of these is made up to the 1st inst. The nominal capital is £25,000 in £5 shares, but only eight shares have been taken up and upon these no call has been made. Registered office Cambridge Street, Birmingham.

Eastbourne Electric Light Company, Limited.—The annual returns of this company for 1885 and 1886 were filed on the 10th inst. The latter is made up to the 20th ult. The nominal capital is £50,000 in 5,000 shares of £10 each. 642 ordinary and 40 preference shares have been taken up and the full amount has been called and paid thereon. An extraordinary general meeting of the company was held on Saturday the 6th ult. at Grove Road Chambers, Eastbourne. Mr. Routledge moved, and Mr. Diplock seconded the following resolution:—"That an agreement bearing date the 18th September, 1886, made between the Eastbourne Electric Light Company, Limited, of the one part and Alfred Spalding Harvey, of 67, Lombard Street, Alexander Henderson, of 28, Austin Friars, and Robert Hammond, of 117, Bishopsgate Street, whereby those gentlemen have been appointed managers for the space of two years and a half from 1st February, 1886, subject to the provisions set forth in such agreement be and is hereby confirmed." The resolution was carried unanimously, and was confirmed at a meeting held at the Gildredge Hotel, Eastbourne, on the 22nd ult., and was duly filed an the 7th inst.

The agreement referred to in the above resolution was registered on the 7th inst., and cites:—That the directors of the company in pursuance of the articles of association, resolved on the 29th March, 1884, to make a debenture issue of £10,000, and in pursuance of such resolution there has been issued, and are now outstanding, debentures amounting to £6,000, and in respect to monies advanced to the company previously to 1st October, 1885, in the proportions following:—To the managers, as purchasers thereof from the liquidator of the Hammond Electric Light and Power Supply Company, £5,500, of which £2,500 bear interest at 6 per cent.; to the Anglo-American Brush Electric Light Corporation, £400; and to Messrs. F. W. Reynolds & Co., £100; and the company has agreed to issue to the managers, as such purchasers aforesaid, debentures of the said issue for the further sum of £1,500 in respect of other monies advanced by the Hammond Company. These debentures are repayable on the 15th April, 1891. The company is also indebted to the managers in respect to advances made subsequently to the 1st October, 1885. The company is at present carrying on its business under great difficulties, and has applied to the managers for further assistance, which they have agreed to grant as follows:—The managers will surrender to the company for cancellation debentures of the nominal amount of £2,000, and forming part of the said £5,500 outstanding debentures and will surrender their right and title to the £1,500 additional debentures, and will also reduce the rate of interest on the remaining £500 of debentures from 7 to 6 per cent. If required to do so by the managers, the company will execute and deliver a mortgage of all its undertakings and property to two trustees, one to be nominated by the managers and one by the company, for the purpose of securing *pari passu* the payment of the principal and interest payable in respect of the said issue of debentures to an amount not exceeding £10,000, such mortgage to be settled in case of difference by Mr. H. Burton Buckley, of 18, Old Square, Lincoln's Inn, barrister. In consideration of such surrender, the company will issue to the managers 350 fully-paid £10 shares.

Lancashire and Cheshire Telephone Exchange, Limited.—The annual return of this company, made up the 9th inst., was filed on the 11th inst. The nominal capital is £400,000 in £1 shares. 300,000 shares are full-paid, and upon 100,000 shares 4s. per share has been called and paid, the total paid-up capital being £320,000. Registered office, 38, Faulkner Street, Manchester.

Standard Time Company, Limited.—An agreement, dated 25th October and filed on the 23rd ult., provides for the sale to this company the letters patent, property, and assets of the Standard Time and Telephone Syndicate, Limited, for £40,000, payable £20,000 in cash, and £20,000 in fully paid up shares.

Union Electrical Power and Light Company, Limited.—The registered office of this company is at 127, Cannon Street, E.C.

LEGAL.

The Direct Spanish Telegraph Company.—In the Chancery Division of the High Court of Justice, on Saturday, Mr. Justice Kay had before him a petition asking for the sanction of the court to the reduction of the capital of the company in accordance with a special resolution that had been adopted at a special meeting of the company. The company was incorporated in the year 1872, and its first transaction was to purchase an existing submarine cable from the Lizard to a point in Spain, the cost of purchase being about £120,000. The company also purchased another cable from Barcelona to a point in France, and with reference to this and other purchases preference shares were created to the extent of £60,000—6,000 shares of £10 each. Shortly afterwards the company's original cable from Spain got in a very bad way, and all the profits of the company were exhausted in keeping up the repairs of the cable, and ultimately the company decided to abandon the cable. A portion of it was picked up, but the expense of doing so was as much as the value of it, and, of course, that was now completely out of the way as an asset. The loss was estimated at £95,000, or one-half of the entire capital of the company, ordinary and preference. The company were, then, in this position. They were advised that it was not proper for them to go on paying dividends, when, in fact, their capital did not exist, and that the proper course to adopt would be to create a reserve fund—the old reserve fund having been used to patch up the cable—and in the meatime to suspend the payment of dividends. The preference shareholders were paid regularly up to the year 1884, but no further dividends were paid. It was then found that to create the reserve fund that would be required would take a period of 10 years, during which time no dividends would be paid, even to the preference shareholders. The alternative course was to reduce the capital of the company. The matter was thoroughly considered at several meetings, and ultimately a resolution was passed in favour of the reduction of capital by one-half all round. A large majority of both preference and ordinary shareholders were of opinion that was the best course, as it would release the reserve fund, and enable a dividend to be declared on account of arrears. Three dissentients voted against the resolution at the meeting, and one of them, Mr. Bannatyne, commenced an action to restrain the company and the directors from proceeding with the resolution. and Vice-Chancellor Bacon granted the injunction, which, however, on appeal, was dissolved. In the present application there was no opposition, and the application was perfectly bonâ fide and within the Act, because having lost £95,000, if the shareholders thought it in their interest, it was perfectly right to write off that amount. On the whole case, therefore, it was submitted that the company had brought itself within the terms of the Act, and that this was a case in which the court might well exercise its discretion in granting the confirmation order. If his lordship took this view and granted the application, it was asked that the company might have liberty to revert to their old form of title and omit the words "and reduced," which had been used since the adoption of the resolution. That could all the more easily be done as it was not a matter in which creditors were affected.

Mr. Justice Kay on Thursday gave judgment confirming the resolution.

Brewis v. Pearse.—In the Queen's Bench Division before Mr. Baron Huddleston and Mr. Justice Manisty, a fortnight ago, this case of Brewis *v.* Pearse and another, was heard and decided. It was an action which has arisen out of proposals to form a company, the Merchants' Mutual Cable Corporation, afterwards the European, American, and Canadian Cable Company, incorporated in 1881 by a special Canadian Act. It was to have a capital of £1,500,000 (a million and a half) in 150,000 shares of £10. The capital was to be obtained by getting persons of capital to underwrite or subscribe their names for certain sums, in the event of the company being floated. The defendants—Pearse, a stockbroker, and Otto Rochs, a German, who it appeared was a promoter—had taken part in the endeavour to form the company. The object of the company was to lay down telegraph cables and form lines of telegraph communication, which were to be laid by Henley's Telegraph Company, which, therefore, had an interest in the formation of this company to find the funds, and were to pay Pearse, it was said, £4,600 when the capital was raised. The Court gave judgment in favour of the plaintiff. Mr. Baron Huddleston said it was eminently a case for the jury; they had heard the parties, and had heard evidence on both sides as to the circumstances. No doubt the plaintiff had run a certain risk to obtain a large profit and had advanced £2,000 in the hope of getting £10,000. There were, however, circumstances inconsistent with the case for the defence, and there was a fact in his favour which it was impossible to get over, and that was the paper he produced at the trial, and which had been mentioned in his affidavit of documents in April, 1883. Mr. Justice Manisty concurred.

Field v. Bennett and Another.—In this case, it will be remembered, Mr. Cyrus Field recovered by default £5,000 damages in an action against Mr. James Gordon Bennett, of the *New York Herald*, for a libel contained in a comment of proceedings which took place at a meeting of the Anglo-American Telegraph Company. An application was made before a divisional court constituted by Lord Coleridge and Mr. Justice Denman to set aside a number of proceedings, including an order of that Court of Appeal permitting substituted service. On Wednesday, Lord Coleridge held that the Court of Appeal had acted beyond its power, and gave judgment setting aside the order of the Court and all subsequent proceedings.

Burroughes v. the Loeb Chemical Electric Light Company, Limited.—In this action, which was one brought by debenture holders for the appointment of a receiver, Mr. Justice Chitty on Friday, last week, consented to the order.

CITY NOTES.

The Commercial Cable Company.—The numbers are published of 400 first mortgage debentures of £100 each, which have been drawn for payment at par at the Union Bank of London, Prince's Street, on Jan. 15th next.

Maxim-Weston Electric Light Company, Limited.—The Exchange Committee has decided to grant a quotation for shares Nos. 250,001 to 300,000 of this company.

The South of England Telephone Company, Limited.—The letters of allotment for the new issue of 10,000 preference shares in this company have been posted.

TRAFFIC RECEIPTS.

he Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 10th were £3,665 after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

NEW PATENTS—1886.

16109. "Electric miners' safety lamps." S. F. WALKER. Dated December 9.

16112. "Primary electric batteries." J. C. LEMMENS, H. G. COTTRELL. Dated December 9.

16141. "Portable electric call alarms." J. R. TOZELAND. Dated December 9.

16151. "Primary voltaic batteries, and preparing the elements and solutions employed therein." W. WEBSTER. Dated December 9.

16157. "Switch for electrical purposes." A. SLATTER. Dated December 9.

16177. "Wind motor for electric lighting, regulating and controlling machinery driven thereby." J. GRIFFITHS. Dated December 10.

16200. "Dynamo-electric generators." F. C. PHILLIPS, H. E. HARRISON. Dated December 10.

16201. "Transforming and distributing electrical energy; appliances therefor." R. DICK, R. KENNEDY. Dated December 10.

16209. "Carbon-regulating apparatus for arc electric lamps." J. D. F. ANDREWS. Dated December 10.

16210. "Commutating apparatus for transmitting electrical currents to and from indicators; commutator brushes." J. D. F. ANDREWS. Dated December 10.

16211. "Apparatus for regulating electrical circuits." J. D. F. ANDREWS. Dated December 10.

16215. "Galvanic batteries." Sir W. VAVASOUR. Dated December 10.

16257. "Primary balancing electric battery." L. HENDLE, J. N. MOERATH. Dated December 11.

16273. "Dynamo electric machinery." E. DESROZIERS. Dated December 11.

16306. "Electro magnetic or magnetic motors and dynamos for producing electricity and motive power combined." G. A. ADAMS. Dated December 13.

16326. "Transforming and distributing electrical energy." R. DICK, R. KENNEDY. Dated December 13.

16352. "Telephones." W. J. MORTON. Dated December 14. (*Complete.*)

16376. "Clipping horses by electricity." T. BLANCHETT. Dated December 14.

16394. "Magnetic regulator for engines." J. D. F. ANDREWS. Dated December 14.

16406. "Electric Motors." N. H. EDGERTON. Dated December 14. (*Complete.*)

16440. "Electric arc lamps." W. J. MACKENZIE. Dated December 15.

16408. "Electric accumulators." A. J. BOULT. (Communicated by P. J. R. Dujardin.) Dated December 14.

16456. "Electrophonetic telegraph sounders." H. A. and H. A. HOUSE. Dated December 15.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

13697. "Improvements in secondary batteries or electrical accumulators." J. Y. JOHNSON. (Commnnicated from abroad by S. Farbaky and Dr. S. Schenek, both of Hungary.) Dated November 10. 8d. Claim:—In and for the manufacture of secondary batteries, or electric accumulators, the described packing mass, or active material, and also the manner of fixing the same in the holes or interstices of the lattice frames without compression, for loosening the packing material without diminishing its cohesion, in order to allow a free entrance and escape of the electrolyte, all substantially as described.

14383. "Improvements in certain elements for electrical batteries." J. T. ARMSTRONG. Dated November 24. 6d. The object of my invention is to cheapen the cost of the elements, or of some of the elements, of electrical batteries; and which invention relates to electrical batteries generally, as well as to the improved batteries described in the inventor's specification, No. $6,878^{85}$. Instead of using two zinc plates, or equivalent plates or bars of other materials, the inventor substitutes for one of such plates another metal such as iron, or he uses two different kinds of metal, instead of using similar metal in both compartments, and thereby obtains equal or greater electrical power with reduced cost. Claims:—1. In electrical batteries, the use of plates or bars, formed of dissimilar metals, substantially as and for the purposes described. 2. In electrical batteries the use of laminated plates or bars formed of dissimilar metals, substantially as and for the purposes described. 3. In electrical batteries, the use of plates or bars formed of metallic alloys, substantially as and for the purposes described. 4. The general arrangements and combinations of metals and alloys, cr of some two or more of them, together constituting the improvements in certain elements for electrical batteries, substantially as and for the purposes described.

1886.

8616. "Galvanometer." O. F. Jonsson. Dated July 1. 6d. Claim :—In a galvanometer the disposition in the bobbin traversed by the current of a fixed greater iron core, and an iron plate with hand acting as a smaller core, and pivotted on a shaft by which disposition the current in the bobbin acts directly upon the plate, and indirectly by magnetising the core so that the plate absents itself more or less from the core in proportion to the power of the traversing current.

9707. "Improvements in telephones and telephonic systems." W. C. Lockwood. Dated July 27. 6d. Consists in providing a local circuit, having the battery and transmitter in electrical circuit, with two spools or helices properly arranged; and the line wires leading to the receivers in circuit with a spool or helix, located between the two spools or helices, the cores of the three spools respectively being separate, but arranged longitudinally in line with each other. Fig. 1 represents a top view of the coils or helices of the local and main lines, in their proper relative positions. Fig. 2 is a view of a transmitter forming part of the local circuit, and fig. 3 is a diagram showing my invention arranged in connection with a complete telephonic system. A, indicates the transmitter, which consists preferably of a casing of suitable shape, having two or more vibrating plates constructed of glass or other suitable material, and mounted between conductors, B, which form a connection between the two binding posts, C, and the wires, D, E, of the local circuit of the system. The said wires connect with the coils of the spools, F, G, and the battery, H, constituting the local circuit. The coils or helices are wound around iron cores, in such direction as to have the opposite poles opposite each other—that is to say, the north pole of one facing the south pole of the other, whenever the coils are subjected to the action of the current from the battery. The letter, I, indicates the coil, or helix, which forms part of the main line or circuit. The said coil or helix is composed of insulated wire wound around a core of soft iron which is located longitudinally in length with the cores of the spools or helices, F, G, but disconnected from the same, and the terminals of the wire forming the spool or helix, I, connect with suitable binding posts from which proceed the line and ground wires of the main circuit, in which the receiving instruments at each end of the line are embraced. The coils or helices, F, G, with their cores, may be adjustably mounted and controlled by set screws, K, L, so that they may be adjusted longitudinally to and from the poles of the coil or helix, I, in order to vary the strength of the current over the main line, according to the resistance offered by the same. The letter, M, indicates a relay which may be located in the main line. This consists of a series of spools or helices, precisely like the spools or helices, F, G, I. The spool, I, is located directly in the line, and the spools, F, G, in the local or battery current of said relay. Claims :—1. A telephonic instrument composed of two spools or helices, adapted to be placed in a local telephonic circuit, and an intermediate spool or helix adapted to be placed in the main or line circuit, the spools having separate or independent cores, substantially as and for the purposes specified. 2. In a telephonic system, the combination with the local circuit embracing a suitable transmitter and battery, of the spools or helices having separate and independent cores, adapted to establish a current by magnetic induction in the main line leading to the reservoir, substantially as specified. 3. The combination with the local spools and their connections, of the intermediate spools and its connections, the cores of the respective spools being independent and separate from each other, and located longitudinally in line with each other, substantially as specified. 4. In combination with the main line spool or helix, the local spools or helices having independent cores, and adjustably mounted at each end of the main spool, and the adjusting screws whereby the local spools may be adjusted to and from the main spool, substantially as set forth.

FIG. I.

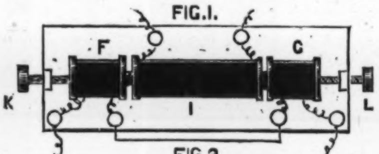
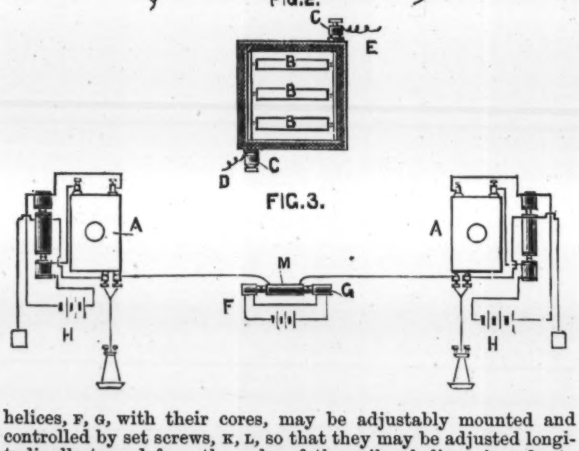


FIG. 2.

FIG. 3.



PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

The concluding general meeting of this society was held on Thursday, December 9th, Professor Hughes, F.R.S., president, in the chair. The minutes of the previous extraordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, the annual report of the council was read by the secretary (Mr. F. W. Webb.) The number of additions to the society during the past year amounted to 6 foreign members, 9 members, 66 associates, and 33 students, or a total of 114. Besides the foregoing, 19 candidates were up for election, 39 associates had been transferred to the class of members, and 13 students to the class of associates. There had been the following losses through death, viz. :—2 foreign members, 1 member, and 4 associates. There had also been a few resignations. The Institution of Civil Engineers continued to grant to the society the use of their lecture hall for the purposes of the society's fortnightly meetings, and with great courtesy had also given permission for any extraordinary meetings which might be found necessary to be held in the hall. A number of papers had been read during the session, only a few of which had been by non-members of the society. The council had decided to award the society's premium of £10 to Mr. A. Bernstein for his paper "On low resistance glow lamps;" the Paris Exhibition premium of £5 to Lieut. Sankey, R.E., for his paper "On the electrolytic deposition of copper;" and the Fahie premium of £5 to Mr. H. Kingsford for his paper "On the localisation of faults in submarine cables." It was much to be wished that more papers would be contributed by the younger members of the society. The Committee on Electrical Nomenclature had held several meetings, and had referred to sub-committees several points which had arisen, it was hoped that before long a report would be issued. The question of a standard laboratory had also been under consideration. As regards the Electric Lighting Act it was believed that this would have been amended during the present year; a petition had been presented on the subject and three Bills had been brought forward, but owing to the dissolution they had been dropped. The library of the society continued to flourish. The finanical position was very satisfactory; the sum of £202 15s. had been invested out of life compositions, and £450 had been added to the general fund. The total amount of investments now amounted to £1,650, the trustees for which were Messrs. Thomson, Clark, and Graves. The report of the librarian stated that 98 volumes had been added to the library and 22 purchased; it was much to be desired that new publications should be presented by the authors. The number of purchases had not been so great as those made last year. The bookbinding account has been rather heavy, but the work had been well done. The number of visitors showed rather a falling off; out of 415, 90 were non-members. The patent specifications continued to be supplied gratis by the Patent Office and had proved very useful. There was a considerable want of shelf space which prevented all the books being seen.

The resolution that the report be adopted having been carried unanimously,

Mr. Shoolbred suggested that a portion of the invested money might be devoted towards providing further shelf space.

The President, in reply, stated that a letter on the subject should be addressed to the library committee, and the matter would be dealt with by the latter.

Mr. Almack enquired whether a circular paper, which had been sent to the members with reference to the proposed new president had been issued with the knowledge of the council.

The Secretary, in the name of the latter, said that this was not the case.

The usual votes of thanks having been proposed, seconded and carrried unanimously, the discussion on Mr. Swinburne's paper, which had been adjourned from the last meeting, was carried on.

Mr. R. E. Crompton considered that in a sense Mr. Swinburne's paper was of great value, as to those working on the subject a record of failures was most useful, it, as it were, buoyed the channel of research. The subject was a difficult one to study as failures are due to so many different reasons. The failure of the lead cells was entirely due to local action and to want of continuity in the substance; he did not think that any amount of compression would ensure absolute lateral continuity. Fault had been found with Gladstone and Tribe's explanations, but he thought that Mr. Swinburne, whilst condemning these explanations, was quite as much to be found fault with. He did not think that a charging in one direction would form a thick film. A clear explanation of the action that took place was, he thought, still required. The use of paraffin oil to cover the liquid with to prevent spurting was unnecessary; if the cells were provided with properly fitting lids, and the leads brought through India-rubber packing, no trouble would be found; of course the lids must not be absolutely tight, as the gas had to escape somewhere. The table showing the comparative bulks of different substances was most instructive, as it explained the cause of buckling. The best plates were those which had the least growth on them.

Mr. Evershed drew attention to a curious phenomenon which he had observed in secondary cells, and that was that at the moment the charging current was cut off a disengagement of gas bubbles took place, this was conclusively proved not to be due to shaking. He had recently tried to ascertain the cause of the phenomenon by seeing whether the bubbles changed their shape, but this was not found to be the case. The use of paraffin oil, he pointed out, would not be of service unless proper oil were employed, lamp oil was of no use, the description used for lubricating purposes was the proper kind.

Lieut. Shipton said that the difficulty of getting good contact in the plates could be got over by using a small current and welding. The best results were obtained from spongy lead; this was bad for the positive plates but good for the negatives. He had succeeded in getting black and green dyes, but only in small quantities, by electrolytic action, and at considerable expense.

Mr. Sydney Walker said that a large quantity of active material was necessary for heavy discharges. Plugged plates were best, as formed plates became exceedingly rotten from want of a backing. In plugged plates there is a danger of the material falling out in consequence of expansion. The direction to work on was that of Planté's old lines, but it was necessary to make very large plates. For house lighting weight and size was not a matter of consequence. The great difficulty at present is the uncertainty of individual cells, as they do not become passive but opposingly active. It was not safe to use secondary cells except when skilled labour was at hand.

Prof. Ayrton had found that ready formed cells were the most convenient to work with. Lead sulphate, he pointed out, had been proved to be the most important element in the cells. This being the case, he would ask why the sulphate was not used in the first instance.

Mr. Drake said that in the experiments he made he had confined himself to one form of cell. The destruction of the conductor is stated to be prevented by the formation of lead sulphate, but others had found just the reverse, and that oxide protects. The table of volumes showed that if the formation of an excess of sulphate could be prevented, buckling would be avoided. He would suggest that the destruction of the flannel was caused by the electrolytic formation of strong sulphuric acid when good circulation did not take place. Spongy lead plates were found effective in fresh water; at a specific gravity of 1·4 no charging could be effected. Zinc plates gave a high electromotive force and a good discharge without the electromotive force falling. He had found that the use of paraffin oil considerably impaired the efficiency of the plates. In reply to Prof. Ayrton he would state that if sulphate were alone employed, no charging at all could be effected.

Mr. Swinburne, in replying, said that with reference to Mr. Crompton's remarks, no prejudicial effects were found from want of continuity. As regards the initial use of lead sulphate, this material would be found too bulky, it would contract and fall off the plates. Minium was used because it was thought it would be converted into peroxide only, but actually sulphate was formed also. The destruction of the flannel was due to the powerful effect which peroxides had on all organic substances. The absence of the fall of electromotive force when zinc was used showed the fall in ordinary cases was probably due to increase of resistance. With reference to a pink formation which Mr. Crompton had observed, he would mention that he had shaken up peroxide with sulphuric acid at intervals for several weeks, and had found that this pink formation took place; he believed it was due to the formation of ferric acid.

Prof. Forbes (during the interval caused by the examination of the ballot papers) made some remarks upon a question which he had been considering, in which he suggested the idea of magnetic currents, *i.e.*, the flow of magnetism. Owing to the extremely short distance over which this magnetic flow took place, it was extremely difficult to make experiments on the subject. There was, he pointed out, a considerable analogy between the magnetic flow and the way in which a charged electric body acted on an electric current.

Mr. Biggs thought that what Prof. Forbes was discussing was really the same thing as the ordinary electrical phenomena.

Mr. Swinburne, Mr. Preece, Prof. Ayrton, Prof. Perry, and Mr. Gisbert Kapp also took part in the discussion, at the conclusion of which the result of the ballot was announced as follows :—

President — Sir Charles T. Bright, M.Inst.C.E. *Vice-Presidents* (four to be elected)—Edward Graves; Colonel Sir Francis Bolton; J. Hopkinson, M.A., D.Sc., F.R.S.; Wm. Crookes, F.R.S. *Members of Council*—William T. Ansell, F.R.G.S.; Prof. W. E. Ayrton, F.R.S.; E. B. Bright, M.Inst.C.E.; R. E. Crompton, M.Inst.C.E.; J. A. Fleming, M.A., D.Sc.; Prof. George Forbes, M.A., F.R.S.E.; Alexander Siemens; Augustus Stroh; Major Charles F. C. Beresford, R.E.; Dr. J. H. Gladstone, F.R.S.; H. R. Kempe, A.M.Inst.C.E.; Sir David Salomons, Bart., M.A. *Associate Members*—J. Brockie; Colin Brodie; C. H. B. Patey, C.B. *Honorary Treasurer*—Edward Graves. *Honorary Secretary*—Colonel Sir Francis Bolton. *Auditors*—J. Wagstaff Blundell; Frederick C. Danvers. *Honorary Solicitors*—Messrs. Wilson, Bristow and Carpmael.

CORRESPONDENCE.

Clark's Standard Cell.

In reply to the question of "Ajax" in your last number as to the proportions of the ingredients of the "paste" in Clark's standard cell.

I have found that provided the solution of zinc sulphate is perfectly saturated, and that more mercurous sulphate than will dissolve in it is present, it is quite immaterial as regards the E.M.F. of the cell how much of the latter salt is employed.

For convenience of transport, however, it is well to add sufficient mercurous sulphate to make the paste of the consistence of thick cream.

Neither zinc carbonate, nor zinc oxide, as I have sometimes used, is necessary, provided the mercurous sulphate is well washed before adding it to the zinc sulphate solution.

Arthur Dearlove.

December 11*th*, 1886.

Electro-Motors and their Government.

In the second column on page 563 of your last issue, there is a short paragraph in an article on motors commencing, "And indeed." From some accident, probably from a slip which contained an addition made to this paragraph having been stuck on to the manuscript in the wrong place, the paragraph is rather unintelligible. Your readers will doubtless have seen what was meant, still we shall feel obliged if you will kindly insert the following, which should replace the paragraph in question :—

"And, indeed, the fact that the power given out by a motor was roughly proportional to the product of the current passing through the armature into the electromotive force, and that the latter, with an armature, having a given number of convolutions of wire, was roughly proportional to the product of the speed into the strength of the field magnets, showed us, before 1882, that if the armature of a motor had but a very few convolutions, either the speed must be high, or the current must be great, or the field magnets must be large in order that the motor might give out much power.

W. E. A.
J. P.

Administration and Working of the British Telegraph System.

In printing my communication on the above subject, the meaning of the second paragraph has been destroyed, by "Postal and Telegraph" being printed for "Telegraph and Postal." The importance of making this correction will be sufficiently obvious.

Whilst writing you will perhaps allow me to draw attention to two points bearing on the financial aspect of the matter.

In 1881 a return ordered by the House of Commons was made for the purpose of showing the position of the telegraph service financially, and prepared on "commercial principles." It showed a profit equivalent to 3·48 per cent. on a capital of over 10 millions of money. Two questions arise : (1) Would this admitted extravagant price paid for the acquisition of the telegraph monopoly, represent at the present time more or less less than the true value of the entire telegraph plant and apparatus of the system, seeing that annual additions of an extensive kind have been made to that plant. (2) Whether it is right to reckon a small return only being made while these annual additions are taking place.

Your readers will no doubt remember the assertion of Mr. Preece in discussing his private electric light installation, that it was the usage of the Post Office to charge what is really capital expenditure to the revenue account in the way indicated.

I venture to suggest that if the Post Office were to take stock "on commercial principles," and make another return to Parliament in 1887, they would show that the despised telegraph branch had not only redeemed the original purchase error of the departmental chiefs, but had established a valuable and handsomely paying national property.

Telegraphist.

December 14*th*, 1886.

[illegible]

[illegible] Works, [illegible] Road, DALSTON,

[illegible]

[illegible]

REVISED [illegible] LIST OF DYNAMOS [illegible] POST FREE [illegible]

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